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AGREEMENT ON ECONOMICS

On Monday last there was released by the British Employers' Confederation a statement entitled "Britain's Industrial Future." The compilation of this document seems to have been undertaken as a consequence of the present pressure on the sterling reserves and out of a desire to find a means of curbing inflation. For the statement opens with a quotation from the Prime Minister who, on August 27th, stressed that "at home we are trying to do too many things at once" and that "at the same time we are consuming more goods at home than we have ever done before," and went on to point out that "we are not in fact paying our way." In general the statement has very little new to say. It points out, what everyone has long appreciated, that this country's position in the world both politically and economically has depended for centuries on our overseas trade; that we enjoyed an "extraordinary advantage" through our early application of new methods in the eighteenth and nineteenth centuries; but that even by 1914 we were beginning to lose that advantage and that, partly as a consequence of two world wars, it has since been almost wholly lost. Indeed, compared with the past it is regarded as a not surprising possibility that there might be "a long-term downward trend in the prices of manufactured products in relation to those of food and raw materials." It is added that "to meet this we shall need to develop new and more economical processes, substitute materials and new products." Coming to the present, it is suggested that the task of increasing our exports has been made more difficult by the extent to which our internal costs and prices have risen; and it is stressed that exporting countries are far more vulnerable to the effects of inflation than countries which are largely self-supporting. Furthermore, inflation has a damaging effect on the internal economy of a country. Constantly rising prices stimulate an excessive demand because of the fear of further rises. Speculation is encouraged. Inefficient employers and inefficient workers can still make a living. The real value of industrial reserves held in securities is reduced. It becomes almost impossible to operate a rational policy for industrial depreciation. Discouragement of personal saving dries up "what has been a major source of capital for industrial development."

Changes in wages and prices in this country during and since the war are next reviewed and it is shown how the two are interlinked and how "an attempt constantly to increase wages so as to catch up with prices . . . . . is bound to be self-defeating. The real income of the country as a whole can in the long run be no greater than the real value of its output." There is, it will be observed, nothing new in this review of the situation as it exists. Nor in fact is there very much new in the Confederation's statement about the causes of inflation and the methods that should be used to combat it. There are references made to the part played in causing inflation by a perhaps too speedy expansion of social services, to the effect of defence expenditure, to political parties "trying to outbid each other in their promises of costly benefits to one section or another of the electorate, leaving the general public to foot the bill," to the effect of heavy taxation in limiting personal saving and to the inflating effect of hire purchase transactions. The answer to these problems is seen succinctly "as the increase of our production as much as possible" and "the reduction of excessive home demands on our resources." Under the first of these heads restrictive practices need to be eliminated, and the uncertainty and disorganisation produced by strikes should become a thing of the past. Under the second the Government must play its part by its own financial policies and by checking the expansion of credit facilities. But the unions, too, must play a large part. "The long continuation of this (inflationary) situation has created an expectation on the part of large sections of the community, and especially among the younger members, that their basic rates of pay should be subject to regular increases at intervals of about a year. . . . What requires to be recognised by employers and workers generally is that in the long run their interests, as well as those of the community at large, will be better served by a reduction of prices. . . ."

None of all this would at any other time attract very much attention. For, less succinctly and usually less clearly, it

has been said time and time again since the war ended. What gives the statement value is that it has been issued just after the Trades Union Congress at which Mr. Geddes and Mr. Heywood advanced very much the same themes and arguments. Industrialists are not alone in appreciating that strikes which disrupt production have inflatory effects. The T.U.C. general council asked for and gained new powers to intervene at an early stage of a dispute because it appreciated that point. The T.U.C. is concerned that industry should be aided to adopt more highly productive methods, even if some of its constituent unions are less enthusiastic. Its council is well aware that increased wages bring no higher living standards *per se*, and that living standards are really ruled by productivity. In fact, nowadays, industrialists and union leaders so well understand the nation's economics that there is in reality little room for disagreement amongst them. Differences only of emphasis survive, as, for instance, in relation to shift working where the employer sees best how expensive machinery can be more fully employed whilst the union leader is more concerned about social implications ; or where, as in this document, the employer can stress (as indeed Sir Stafford Cripps once stressed, too) that his and his employees' long-run interests would be better served by a reduction of prices consequent upon higher productivity than by an increase of wages, whereas the union leader will emphasise that the workers must share in any benefits that " automation " brings to a firm ; or, again, where the employer pleads for a greater sense of responsibility amongst workers when urged to strike, bearing in mind repercussions upon other industries, whilst the union leader stresses that there may be no other way of calling attention to the fact that wages are unduly low in a particular industry. But, in fact, thinking men on both sides now realise that there is very little room for argument left open. Seventy or eighty years ago there was long and sometimes quite acrimonious correspondence in our columns on technical subjects. We do not get such letters now. A mathematician would certainly intervene with an exact answer to the problem, thus bringing all arguments to an abrupt end ! Economics is becoming nowadays so well understood a subject that something of the same kind is happening. There is no longer room for argument about causes and effects. There is room only for differences of opinion about whether foreseen effects will be nationally beneficial or not, and not much room even there ! Mr. Pollock, director of the Confederation, said in presenting the statement that he hoped the T.U.C. and the Confederation could get together and consider the situation. It really seems to us possible, after reading the document, and after reading about the T.U.C. sessions, that the Confederation and the T.U.C. council should be able to draw up an agreed document. If they could the Government could certainly confidently act upon its conclusions.

DEFENCE QUESTIONS ON THE HORIZON

The difficulties of devising an acceptable scheme for the control of the hydrogen missile are now becoming more generally recognised and there seems no likelihood in the near future of any significant reduction in the level of defence expenditure of either the United Kingdom or the United States. The latter's defence budget for 1955–56 is no less than 34 billion dollars—approximately £12,000 million—and though our own current defence expenditure of £1537 million is small in comparison, it is none the less a very heavy burden for this country. To what extent defence orders and requirements are responsible for the present full employment and high standard of living is a matter of opinion, but in any event the policy of relying on the deterrent value of the hydrogen missile is the best and a reasonably sure guarantee of a lasting peace. We may in fact anticipate that from now onwards there will be less talk of the probability of war. Public interest is likely to be focused more on the effect of new weapons on the size, tactics and strategy of the Armed Forces. The detonating arrangements for the atomic weapon now permit its use in fighter bombers, in heavy guns and in guided missiles of the " Corporal " and " Redstone " types, and the Supreme Commander, Europe, has made it clear that it will be necessary to use it in the event of aggression. Plans are already being made for armies to operate in much smaller units, capable of rapid dispersion and concentration, and to employ air transport and highly mobile tanks to the fullest possible extent. Hydrogen explosive, on the other hand, seems less suitable for use in the field, in view of its immense and wide destructive and " fall-out " effects.

Both kinds of explosives, however, appear likely in the not distant future to introduce fundamental changes in the tactics of air forces and navies and in the tasks given to them to do. Little or no official information on the subject is released in this country, but from the guarded official and semi-official pronouncements in the United States it is possible to gain some idea of the situation which will develop during the next fifteen to twenty years. Expert opinion is unanimous that over this period aircraft will continue to provide the most effective means of delivering the hydrogen missile. Experts also agree that by the end of that time aircraft will find it extremely difficult, if not impossible, to drop bombs over a target in view of the increasing efficiency of anti-aircraft guided missiles. They do not, however, agree on what will then provide the most effective missile carrier. It is claimed on the one hand that the heavy bomber will not itself proceed to the target but will release a pilotless bomber or medium-sized guided rocket of the Bell Raseal type, when 200 or 200 miles away, and thus be immune from hostile anti-aircraft defence. Other experts point out that the free-flying ballistic rocket with ranges of up to 5000 miles will soon be available and that with a hydrogen explosive warhead its danger space should be small enough to give decisive results.

It is important to note in this connection that the ballistic rocket is of the V-2 type and unguided. One day it may be possible for a missile to use stellar navigation—to compute its position and course from observation of the stars. But that day is not yet in sight. This is not to say that it is impossible to produce a long-range guided rocket. Indeed, one of these missiles—the " Navaho," now under development in the United States—shows every promise of early production. But its trajectory must be kept within the atmosphere, which means that its speed cannot be very much higher than the speed of a supersonic fighter, and such missiles, if very large, are, like the pilotless bombers of the " Matador " or " Regulus " types, liable to be shot down by anti-aircraft defence. None the less, if and when bombers are no longer able to operate against the anti-aircraft missile, there would seem to be a strong case for building a new class of capital ship of about 20,000 tons to launch smaller guided rockets of this kind, with a range in the region of 500 miles. The Royal Navy would thus provide a highly mobile strategic bombing force. Such a force, it may be noted, is now being provided by the huge 60,000-ton United States aircraft carriers, though in the British view there seems no real need for it at the present time. Another question of interest is the kind of missile which will be used in actions between surface ships. The Royal Navy has to ensure that we have our essential requirements of food, oil and raw material—or, alternatively, of manufactured goods if our factories are devastated. While aircraft continue to provide the striking power of the fleet the guns of cruisers give them adequate support. But cruisers on the trade routes will not always be accompanied by a carrier and the ship which can open fire with guided rockets at a range of 100 or 200 miles would be at a great advantage. She would also have an obvious value in supplementing the attacks of our carrier borne strike aircraft on submarine ports and war potential installations in coastal areas. Meanwhile, however, unless similar types of ships of potentially hostile nations are to be armed with ship-to-ship or ship-to-surface guided rockets, there is no urgent call for them in the Royal Navy. Our most pressing need is to replace our ageing cruisers with new ships equipped with the most modern anti-aircraft protection.

A Seven Day Journal

List of Centenarian Firms

IN a Centenary Number to be issued to mark the Centenary of this journal on January 4th next year there will be included a list of British manufacturing and consulting firms, institutions and societies and journals operating in the fields covered by THE ENGINEER which will have celebrated their Centenaries by January 4, 1956. To ensure inclusion in the list each such firm or society in the engineering and allied industries, the iron and steel industry, the shipbuilding industry, and any other industries whose activities are commonly reported in THE ENGINEER, should inform us about the date of its foundation, its title at that time and its present title, before September 23rd next, addressing the communication to The Editor, "The Engineer," 28, Essex Street, London, W.C.2.

Road Traffic Census, 1954

A SAMPLE of the traffic counted on main roads during the Ministry of Transport and Civil Aviation's 1954 road traffic census shows that the average number of mechanically-propelled vehicles passing the 300 points selected for the sample was 38 per cent greater than before the war. There were twice as many goods vehicles, 41 per cent more buses and coaches, and 19 per cent more private cars. But the number of pedal cycles was a third less than in 1938 and horse-drawn vehicles were very few. The 1954 census was the first comprehensive census since 1938. It covered 5830 points on trunk and Class I roads and lasted seven days, from Monday, August 16th, to Sunday, August 22nd. Counts continued from 6 a.m. to 10 p.m. each day and there was also a night count at selected points during the intervening eight hours. The full results are still being studied and summarised, but the sample of 300 points has been specially analysed by the Ministry to assess the changes in the volume and character of traffic. These 300 points were situated on the more important trunk and classified roads in all parts of the country. The largest percentage increase in mechanically-propelled vehicles occurred at the points in Wales, where both goods and passenger traffic were heavier relative to 1938 than at the remaining points. Numerically the largest increases occurred at points in the metropolitan area. The percentage of goods traffic passing all points amounted to 26 per cent of all mechanically-propelled traffic compared with 18 per cent in 1938. Over half the mechanically-propelled traffic, however, was still made up of private cars. In the motor-cycle class 70 per cent were solo machines, including 7 per cent of motor-assisted pedal cycles. There were only slight variations in volume and composition on the five week-days at the 300 points, but much greater changes on Saturday and Sunday. The volume of mechanically-propelled vehicles of all kinds rose by 20 per cent above the week-day figures on the Saturday. There were approximately 50 per cent more cars on Saturday and 40 per cent more on Sunday than on the five week-days, while goods vehicles were naturally much fewer on both days, being down to just over half the week-day figure on Saturday and to less than a quarter on Sunday. On week-days the peak hour at the 300 points was 5–6 p.m., when more than 9 per cent of the day's traffic passed. On Saturday the peak occurred earlier (between 2 p.m. and 3 p.m.) and on Sunday it occurred between 7 p.m. and 8 p.m., when over 10 per cent of the day's traffic was recorded. The Ministry points out that the changes in traffic at these 300 points probably indicate the changes which occurred over the whole country during the census week, but they do not necessarily represent the traffic throughout the year. The majority of the census points, in the full census and in the sample, were outside the built-up areas of towns so that the results reflect, in the main, conditions on the open road.

Oil Fuel and the Industrial Revolution

AFTER a luncheon given by the Associated British Combustion, Ltd., on Thursday of last week at Grosvenor House, there followed an informal discussion upon the role of oil in the new industrial revolution. In opening the discussion Commander R. B. Cooper, the chairman of the company, likened the industrial revolution of to-day and the part played by liquid fuel with the industrial revolution of 100 years ago which was linked with the mechanical mining of coal. New industries had helped to replace the loss of exports of older products and to raise the standard of living, but, he continued, we wanted greater productivity which involved more mechanisation, power and fuel, so that since Great Britain was now a net importer of coal, oil and atomic power would have to provide the additional energy. However, until the atomic era arrived oil would have to fill the gap so that the oil companies had a major part to play and, he continued, the oil burner manufacturers also had to carry a heavy responsibility to provide the necessary equipment in the interests of the national economy. He did not feel that the new revolution involved fear of unemployment, but more automatic control did mean less manual labour and more technicians. The latter were essential if complicated plant was to be operated efficiently and he said that schemes were in hand to ensure the training of technical staff. His own company, he went on to say, which was expanding to meet the increasing demand for oil equipment and had just introduced a new burner for shell boilers, realised the comparative newness of oil burning installations and was commissioning a mobile unit to give on the spot demonstrations. Other speakers emphasised that industrial development had outstripped coal development, deplored the purchase tax on domestic burners, called attention to the correct use of air, and referred to lectures and practical tuition in the use of oil burning equipment.

World Bank's Annual Report

THIS week the International Bank for Reconstruction and Development has made public its tenth annual report, which covers the year ended June 30th last. The report describes the year as the most active in the Bank's history, and comments that it was also "a year of improving economic conditions in the world as a whole." At the end of the year, the report says, the Bank's total loan commitments, since the start of its operations in 1946, amounted to more than 2300 million dollars lent in thirty-seven countries in six continents; reserves stood at about 185 million dollars and the total of bonds outstanding was approximately 850 million dollars. In addition to giving particulars of projects financed by the Bank during the year reviewed, the report contains some details of the progress made in carrying forward projects financed in previous years. This progress, it is stated, was "perhaps greater than in any other year." Among the matters noted as achievements in various countries in the past year, with the help of Bank loans, are the completion, in Brazil, of one of the world's largest underground power stations, near Rio de Janeiro, the completion of Latin America's largest steam power plant, near Sao Paulo, and the completion of a hydro-electric plant on the San Francisco River, despite difficult engineering problems. There is also mention of the marked improvement in rail services in East and West Pakistan resulting from the use of diesel locomotives. On the North Western Railways alone, the report says, these are making possible a foreign exchange saving on fuel of about 1,000,000 dollars a year. Other achievements recorded are the completion of thirteen industrial projects in Turkey, the restoration to a useable condition of nearly 2500 miles of primary roads in Ethiopia, and the improvement of basic services in the Belgian Congo under a ten-year development plan. These latter include the improvement of the ports of Leopoldville and Matadi, the improvement of rail transport between those two towns, and of navigational facilities on the Congo River.

Cornish Engine Preservation Society

ON Saturday of next week, September 24th, the Cornish Engine Preservation Society is to hold its annual meeting at Camborne. The morning will be devoted to an inspection of the work of preservation of various engines which the Society has in hand, and the business session will be held at 3 p.m. in the Lecture Hall of the Holman Museum, Camborne. Following the routine business, Mr. T. C. Stevens will read a paper on "Cornish Engines and the Severn Tunnel." The Society reports that on May 1st last the century-old 80in Cornish pumping engine at Robinson's Shaft, South Crofty mine, finished work. It was the last Cornish engine to work in a Cornish mine and the directors of the mine have decided to present the engine to the Society for preservation. It will shortly be transferred to the Society's care. During recent months, the council of the Society has had the houses of the Harvey 90in engine and of the East Pool beam winding engine thoroughly repaired, and a tender has already been accepted for the necessary repairs to the house of the 80in Robinson engine. The total cost of all these repairs will exceed £1000 and will therefore absorb the Society's general fund, which now totals £1052. In addition to the structural repairs and decorations in hand or completed by the Society, Holman Bros., Ltd., has undertaken the overhaul of the beam winding engine at East Pool and is installing an electric motor and gearing for working the engine. Information about the objects and work of the Cornish Engine Preservation Society are readily available from the honorary secretary, Mr. W. Tregoning Hooper, St. Anthony Cottage, St. Agnes, Cornwall.

Properties of Materials at High Rates of Strain

THE council of the Institution of Mechanical Engineers, in collaboration with its Applied Mechanics Group committee, is taking steps to organise a conference on "The Properties of Materials at High Rates of Strain," to take place in London in March, 1957. It is stated that the materials under consideration at this conference will include only those used in the manufacture of

mechanical engineering structures or elements, and will exclude fluids. The conference will largely take the form of the presentation and discussion of a series of papers and arrangements will be made to issue copies of these in advance. The meeting will probably last from two to three days. It is expected that the papers will be grouped under the following six main subject headings: metal physics; experimental techniques; wave propagation strain-rate effects on small strains; metal working; non-metals; basic properties. The council of the Institution says that it is ready to consider the publication of manuscripts submitted in connection with this proposed conference. In order to allow sufficient time for the refereeing of manuscripts, the latest date for submission to the secretary will be September 30, 1956, but authors should notify the secretary as early as possible of their intention to submit a paper, and finished manuscripts should be sent in without delay. Full details of the arrangements for the conference will be published in due course.

Obituary

ROBERT BLACKBURN, O.B.E.

MR. ROBERT BLACKBURN, founder of the firm of aircraft constructors that bears his name, died in his home at Exeter on September 10th.

Born in 1885, he attended Leeds Boys' Modern School and studied engineering at Leeds University with the intention of entering his father's engineering works in Leeds. He worked with several large firms in Germany, and went to France to work with a consulting civil engineer. While there he saw Wilbur Wright fly, and left Rouen for Paris, frequently visiting Issy, where, during 1908, Bleriot and Santos-Dumont monoplanes took the air. His own first monoplane was designed in Paris but built in Leeds,, and in October, 1909, was flown from the beach at Saltburn and crashed. The 1910 Blackburn monoplane was flown successfully by naval officers before World War I, and during that war the Blackburn Aeroplane and Motor Company, Ltd., Olympia, Leeds, produced land-and sea-planes principally for the Admiralty. Another monoplane design was the sporting "Sidecar" of 1919, intended to sell for £450, but the requirements of the Navy resulted in a succession of braced biplanes such as the "Baffin." In size, the aircraft ranged up to the "Perth" flying boat, with six R. R. Buzzard engines. In the middle 'thirties the Cirrus Hermes aero-engine company was merged into Blackburn Aircraft, Ltd.; the range of "Cirrus" engines culminated with the introduction after World War II of the "Bombardier," distinguished among air-cooled engines by its overhead camshaft and fuel injection system. This war also saw Blackburn aircraft at sea, the "Skua" being the Navy's first monoplane. The company also built Fairey "Swordfish," which sometimes were referred to as "Blackfish." A merger with General Aircraft, Ltd., was followed by the construction of a very large four-engined freighter for military and civil purposes; the "Beverley" and the range of "Turboméca" turbines built by Blackburn and General Aircraft, Ltd., were on show when Blackburn visited Farnborough three days before his death.

Blackburn was a member of the Institution of Mechanical Engineers since 1920, a Fellow of the Royal Aeronautical Society, and an associate member of the Institution of Civil Engineers. He is survived by his second wife, two sons and four daughters.

Engineering, Marine and Welding Exhibition

No. II—(*Continued from page 362, September 9th*)

THE twentieth Engineering, Marine and Welding Exhibition, which has been held at Olympia, London, ended yesterday. During the fortnight in which the exhibition was open, it was visited by many engineers from this country and from overseas. We continue here our description of some of the numerous items of equipment which were exhibited.

CLARKE CHAPMAN AND CO., LTD.

Items, either as full scale exhibits or in model form, represented the many engineering products manufactured by Clarke Chapman and Co., Ltd. Among the deck auxiliaries were two new units, namely the totally enclosed, splash lubricated steam windlass and a warping capstan of similar design, both of which have successfully completed proving trials under service conditions covering a period of two years.

Fig. 18 shows the steam windlass which is the modern counterpart of the unit now extensively in service in the Merchant Navy. A powerful twin cylinder, double-acting, horizontal, reversible steam engine drives the port and starboard warping ends and cable lifters through spur gearing. An oil tight case encloses the engine parts and gearing and ensures splash lubrication throughout. The outer frame bearings are lubricated by grease cup while the cable lifters, which are a press fit on the main shafts and are engaged by sliding main pinions, do not require lubrication. High duty iron is used for the strongly constructed bedplate and frames, the cable lifters and warp ends, while the cylinders and control chest are in a single casting of close-grained cast iron. The pistons are of cast iron and have one broad ring, the engine rods are of wrought steel, the connecting rods have adjustable crank pin bearings, and cast steel is used for the gearing which has machine cut teeth. The capstan has a similar specification.

Another exhibit was the automatic chain lubricator, which is suitable for use with chain conveyors, elevators, casting machines and escalators. It consists of an oil tight aluminium case enclosing all the mechanism and forming an oil bath for providing splash lubrication. The lubricator works in conjunction with the chain sprocket wheels and is independent of speed of chain, and provision is made for the nipple connectors to accommodate a limited amount of wear on the sprocket teeth. Skilled labour is not required for the operation of the unit which is engaged by the movement of a hand lever, on the outside of the casing, which slides the unit along a stub axle to engage with the sprocket wheel. At a set point a cam lifts a rocker arm roller to push forward a self-centring plunger which engages with a chain nipple. With the nipple connector pressed firmly upon the nipple, an injector ram engages with a further cam and forces lubricant through a linking length of high-pressure flexible piping to the chain nipple and into the chain bush and roller.

A model demonstrated the working of an overside ship's lift which has been designed to avoid the dangers of boarding ships by slippery, steeply angled ladders and gangplanks. It can also be used at sea for taking on stores or passengers from launches, or for giving easy access to the floor of a dry dock. The car is of aluminium alloy construction with doors on outboard and inboard sides and extends some 15ft from the ship's side at the lowest point of travel. Two men can rig the lift in a few minutes and the lift, which is unaffected by list or trim, incorporates an automatic stopping device, consisting of a weight, suspended on a lanyard below the car, which upon touching the quay engages a cam to stop the lift. A winch driven by a squirrel cage motor of 17½ h.p. drives the operating mechanism to give the lift a speed of 120ft per minute.

DEWRANCE AND CO., LTD.

A selection of boiler mountings and piping valves was shown by Dewrance and Co., Ltd. It included a "Consolidated Maxiflow" safety valve, which is a full lift unit designed to protect adequately the modern high-duty boiler and provide maximum discharge capacity. A thermodisc is fitted in the valve head and promotes rapid equalisation of temperature differences between seat and disc, and so prevents distortion and subsequent leakage. A number of the company's

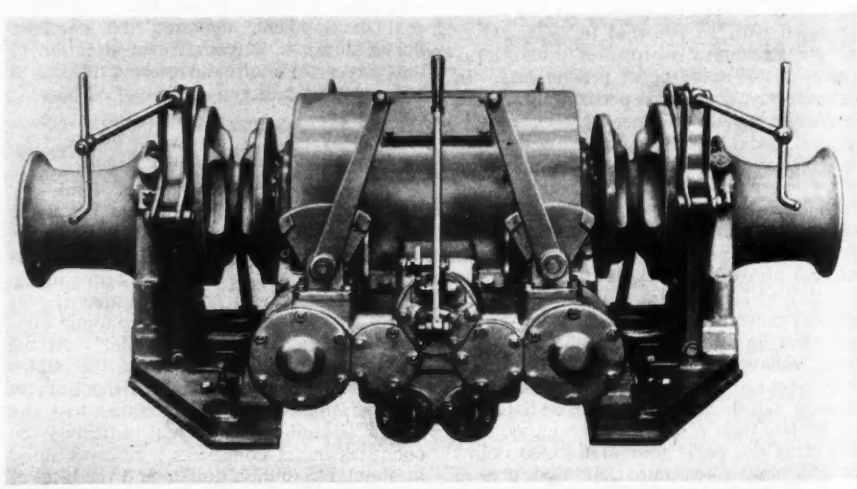


Fig. 18—Horizontal totally enclosed splash lubricated steam windlass—Clarke Chapman

water level indicators were on view, including the Dewrance-Marconi television equipment.

Another item on the stand was a demonstration unit showing the company's electromatic relief valve, which may be set to relieve pressure at a pressure of ±1 per cent. The valve head is held to its seal by full boiler pressure and cannot chatter, and its action is governed by positive electrical control. This valve has a capacity in excess of the conventional safety valve so that the latter need not blow except in an emergency;

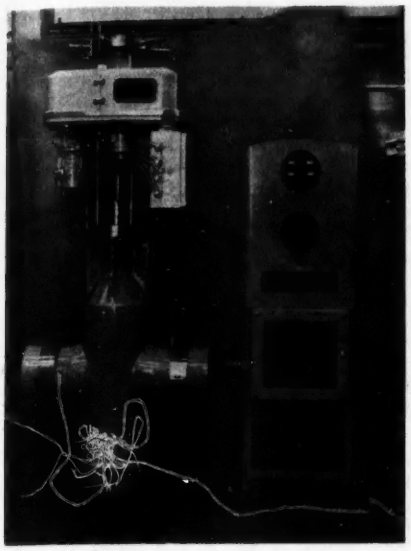


Fig. 19—Dewrance-Tate five point air rotary unit—Dewrance

however, it does not replace the safety valve but is rather a supplementary valve designed to conserve power and increase efficiency. Temperature does not affect the control mechanism, and the pressure at the boiler drum, superheater outlet or steam header can be used for control purposes and is used to actuate a pressure-operated switch.

High-pressure pipeline valves were shown, in which the seal is made by the fluid pressure forcing an internal cover to compress a Dewrance patent fluid metallic packing ring, thus eliminating the more normal heavy cover flanges and bolting. A parallel slide valve, having a fabricated body, and suitable for steam pressures up to 900 lb per square inch and a temperature of 900 deg. Fah., and fitted with a Dewrance-Tate five point air rotary unit, was also exhibited, shown in Fig. 19. Control gear was included consisting of a five point four light panel mounting controller and independent four flag pneumatic indicator. The unit consists of a turbo-reversing air motor, main valve and by-pass valve piston operated clutches, so arranged with the respective valve spindles that the motor operates the main valve or by-pass valve according to which of the clutch pistons is charged. Both motor and mechanisms are strongly built, and the maximum power is sufficient to operate the valve against the friction load with full pressure on one side of the disc and zero on the other.

Fluidrive Engineering Co., Ltd.

On the stand of the Fluidrive Engineering Co., Ltd., were several examples of the company's products including two of the latest developments, the Vulcan-Sinclair size 29, dual Fluidrive with self shifting synchronous gear and a size 12.75 dual Fluidrive with reverse gear. The size 29 unit represents an advance in the transmission of power in the hydro-kinetic field. The principle of dual Fluidrive is based on two fluid circuits having two scoop tubes for emptying and filling and thus transmitting power through the centre or sleeve shafts. As developed, the system is suitable for oil drilling, marine propulsion, winches and hoists where reversing is necessary and the actual exhibit, with its two-speed S.S.S. gearbox, was intended for service with a diesel locomotive powered by a 500 constant horsepower supercharged engine. The unit is suitable for locomotives having a drawbar pull of 32,000 lb and a maximum speed of 20 m.p.h.

A squirrel cage motor providing flexibility of control and rapid reversal of load drives the size 12.75 dual Fluidrive system. Power is transmitted by a centre shaft, or a sleeve shaft, to two pinions, one pinion driving the output shaft, the other driving through an idler gear train to reverse the output shaft. Oil in the two fluid circuits is controlled and rapidly transferred from one to the other by a rack operated scoop. For exhibition purposes the unit which is intended for a 40 h.p. reversing winch had a flywheel of reasonably high inertia mounted on the output shaft.

In order to meet the demand for units to drive high-power high-speed boiler feed pumps, turbo-compressors, gas boosters and other plant where quick response infinitely variable speed regulation is essential, the company is engaged in extending the range of Vulcan-Sinclair scoop trimming fluid couplings. A squirrel cage motor forms the drive and on the stand was a size 22¼ S.T. fluid coupling, Fig. 20, mounted on a common bedplate with a David Brown speed increasing gear. At an input speed of 2950 r.p.m. the coupling delivers 2000 h.p. at 4000 r.p.m. of the output shaft. This design of fluid coupling has no rotating reservoir, such as that embodied in the scoop control unit, but a stationary reservoir containing the oil with the coupling at rest. Oil is delivered to the working circuit, through water operated coolers, by a motor-driven circulating pump and the amount of oil and hence the output shaft speed is controlled by the movement of a sliding scoop.

Fully sectioned examples of traction and scoop-control fluid control couplings were on view, also working models and a size 8SCR6 coupling as used for the driving of the electric winch used in the flight refuelling of jet aircraft.

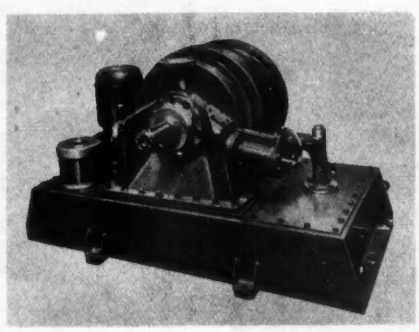


Fig. 20—Size 22¼ scoop trimming fluid coupling—Fluidrive Engineering

W. H. Dorman and Co., Ltd.

Three examples of the engines built by W. H. Dorman and Co., Ltd., formed the exhibit on the company's stand. These were a 6KA/M marine engine, a 6KA industrial engine in complete power pack form and a 6LA engine in fan to flywheel form. The four-stroke Mark 6LA engine, shown in Fig. 21, has six cylinders of 120mm bore by 130mm stroke, a compression ratio of 15·5 to 1, a compression pressure of 475 lb to 540 lb per square inch, and a maximum firing pressure of 900 lb to 1000 lb per square inch. A rigid cast iron structure forms the crankcase and cylinder unit which has underslung main bearing caps and houses chrome hardened wet liners. The cylinder heads, of high grade cast iron, have integral rocker brackets and a high wall valve chamber housing overhead valves, rockers and injectors. Low expansion aluminium alloy pistons having three pressure rings and two slotted oil rings are fitted, and the "H" section alloy steel connecting-rods have steel backed prefinished copper lead-lined big-end bearings and a silicon bronze bush at the small end. Seven prefinished steel-backed, copper lead-lined bearings support the crankshaft. The camshaft is of high duty iron and the chill-cast cams operate chilled face bucket tappets. Each cylinder has one inlet and one exhaust valve which are actuated by push rods and hardened overhead rockers.

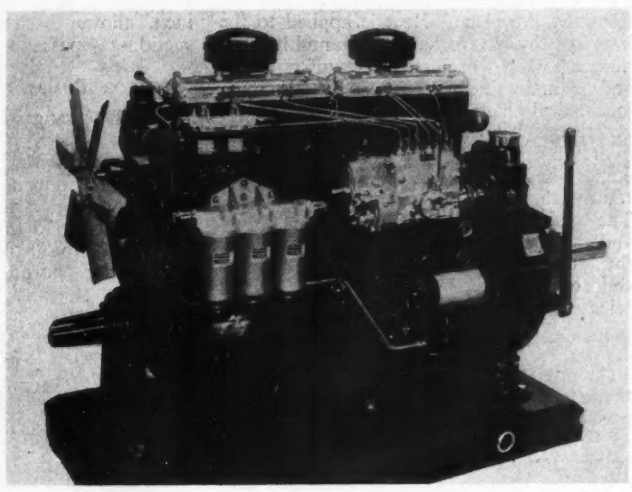


Fig. 21—Mark 6LA six-cylinder industrial engine—W. H. Dorman

A lift pump delivers fuel from the tank to the fuel filters and it is then delivered to the engine by a C.A.V. injection pump through four-hole nozzles. Lubricating oil is carried in a detachable sump and is pumped to a triple element fuel flow and filter to the bearings by a high capacity gear pump. Cooling water is circulated by a belt driven centrifugal pump. The electrical equipment includes a 5in cradle mounted axial starter, and a flange mounted dynamo driven from the main gear train.

Royal Navy

On the Royal Navy stand a number of models illustrated naval developments, and that of aircraft carrier H.M.S. "Eagle" demonstrated the angled deck and the position of the steam catapult, of which there was a working model together with one of the mirror aid to deck landings.

Other models showed the Rolls-Royce "R.M.60" gas turbine installed in H.M.S. "Grey Goose," an Admiralty Standard Range I, 16 cylinder, vee internal combustion engine intended for certain new frigates, a Napier "Deltic," 18 cylinder propulsion unit, and a Paxman and a Mirrlees propulsion unit as fitted in the coastal minesweepers. An X-ray machine, using fission material for the production of radiographs of welds, was shown and there was also a portable Burton pressure butt welding machine for the welding of steel pipes. In this machine low hydraulic pressure is applied to bring the prepared pipe faces together, and then a control rod, carrying contacts actuating electrical limit switches, is locked to the moving part, and by recording linear dimensional change causes the sequence of operations to take place. Heat is applied to the interface by an oxy-acetylene multiple jet burner, which oscillates circumferentially, and is maintained on the joint line by a mechanical half travel device. When a preset expansion is reached a second higher hydraulic pressure is applied which overcomes the thermal expansion pressure and returns the pipe to its original cold length. The weld is formed by a high final pressure and the upsetting continues until stopped by the preset travel allowance switch which shuts off the gas supply to the burner and then releases the hydraulic pressure.

York Shipley, Ltd.

Among the refrigerating machinery on the stand of York Shipley, Ltd., there was a compressor having sixteen cylinders of 3¾in by 3in bore and stroke, the cylinders being arranged on four banks, each bank consisting of two pairs of cylinders with pistons arranged at 180 deg. apart to give dynamic balance and vibration free operation. The compressor shown in Fig. 23 is started on one bank of cylinders, thus reducing starting power requirements, and the other banks are arranged to be brought in by means of a thermostat control in the lubricating oil system.

The housing is of high duty close-grained iron and contains cylinders, crankcase, suction strainers and relief valves and is equipped with hand-hole plates. Cast alloy iron sleeves form the cylinders and the design provides for these and all other parts subjected to wear to be easily removed. The cast iron plug pistons have two chrome plate compression rings and one oil scraper ring, and the crankshaft is of cast "Meehanite" or of forged steel with specially hardened cranks, while the connecting-rods are of aluminium alloy and drilled for lubricating purposes. Ring plate suction and discharge valves of tempered Swedish steel or stainless steel with a cast iron retaining plate are fitted, and the suction valve is larger than the cylinder bore. The valves are pinned to give increased life by preventing wear by rotation. A packless diaphragm shaft seal with surfaces under constant oil pressure reduces refrigerant and friction losses, and the load and thrust bearings are of Babbitt sleeve pattern, all being pressure lubricated by a gear pump equipped with an external disc pattern oil filter. External discharge manifolds keep the compression heat from the working parts, and a spring loaded ball check pressure relief valve, operating at a pressure differential of 250 lb per square inch, allows discharge-gas to escape into suction-gas passages.

Megator Pumps and Compressors, Ltd.

Two new ranges of pumps were shown by Megator Pumps and Compressors, Ltd. They were the Mark "K" and "R" units. The "K" group of pumps, which have the main working parts in common, range in capacity from 75 to 300 gallons per minute or from 25 to 80 tons per hour when rated for marine purposes. The new pumps

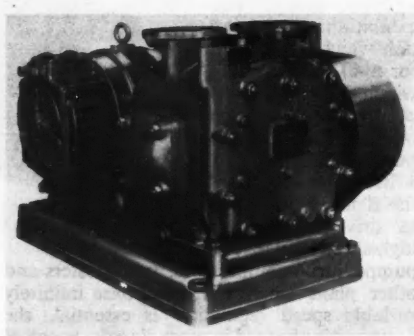


Fig. 22—"K.3" pump with marine d.c. motor —Megator

operate on the Megator sliding shoe principle, which is a simple mechanism providing in a high-speed rotary form the equivalent of a multi-ram reciprocating pump with mechanical valves.

The "K3" pump, as shown in Fig. 22, has a marine rating of 30 tons per hour and is belt-driven by a d.c. motor. It has constant-capacity characteristics, the head being independent of the speed and the capacity substantially proportional to it. There are three shoes which are made of "Megarthene," a mixture of synthetic resin and synthetic rubber, and the pumping action is derived from the rotation of three eccentric discs which are set at 120 deg. to each other on a shaft and fit closely into the rubber lining of the shoes. The discs impart a vertical motion to the shoes to cover and uncover suction and discharge ports while their horizontal motion provides the necessary displacement. The whole of the belt pull is taken by a large-size single, self-aligning ball bearing, the inner ring of which is mounted on a fixed extension of the pump end cover and the tapered end of the rotor shaft fits into a hub bolted to the pulley. The thrust from the belt drive and the radial thrust at the driving end of the rotor, arising from the hydraulic pressure on the discs, is taken by the ball bearing. The radial faced shaft seal can be extracted without disturbing any other part of the pump after the removal of the hub from the shaft, which is then supported by the seal back plate. A synthetic rubber bearing carries the other end of the shaft and permits a wide variation in alignment as does the shaft seal and the fact that the shoes float in the discs.

An "R" pump having a capacity of 16 gallons per minute and representative of pumps covering a capacity range of 5 to 16 gallons per minute was also exhibited, together with a "G.H.4" mining pump, capable of delivering 160 imperial gallons per minute against a total head of 350ft.

R. L. Engineers, Ltd.

Several examples of an engine which has been under development for a number of years were shown by R. L. Engineers, Ltd. The engine is the result of seven years research by the engineers of the Rootes Group and its application for marine and industrial purposes has been carried out in conjunction with R. A. Lister and Co., Ltd. The T.S.3 unit, seen in Fig. 24, is a three-cylinder, direct-injection, water-cooled, horizontally-opposed two-stroke diesel engine with blower assisted scavenge, having a capacity of 3261c.c., a bore of 3·25in, and a stroke of 4in by 2in. Each piston is linked to the alloy steel, drop-forged crankshaft, which is carried in four thin wall, steel-backed white metal bearings and lies centrally below the cylinder barrels, by a piston rod, rocker lever, and connecting-

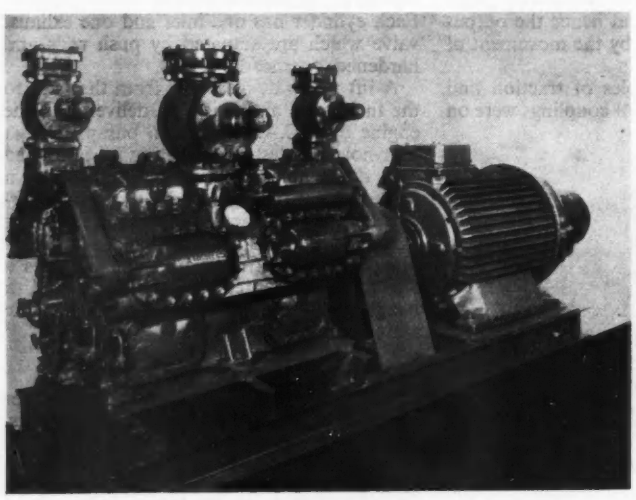


Fig. 23—Sixteen-cylinder compressor—York Shipley

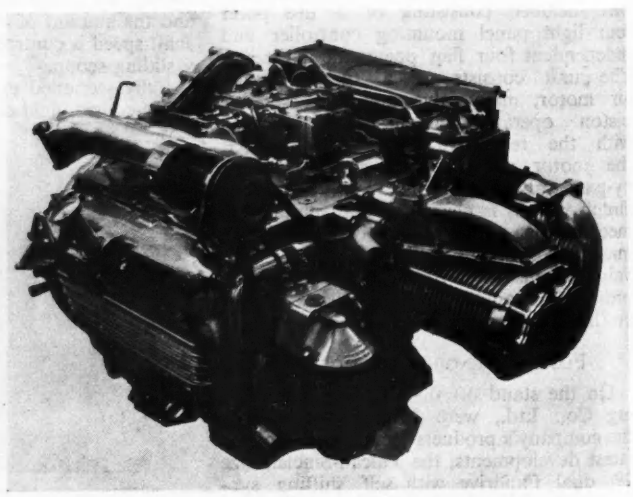


Fig. 24—"T.R.3" opposed piston engine—R. L. Engineers

rod. The piston rods and connecting-rods are "H" section manganese molybdenum alloy steel forgings, the former having lead bronze bushes and the latter having thin wall, steel backed shell big end bearings with lead bronze upper halves and lower halves of white metal, while the rocker levers are of the same material with lead bronze bearings and end bushes. The cast iron pistons have a composite fire ring, two wedge pattern compression rings, a stepped air seal ring and a two-piece scraper ring.

An iron casting forms the cylinder block and crankcase and contains cast iron wet cylinder barrels, each of which has a belt of inlet ports at one end and exhaust ports at the other, replacing the conventional valves. A C.A.V. unit embodying a fuel lift pump supplies fuel to single-hole injectors and a gear pump maintains high pressure lubrication of the bearings, while a centrifugal pump deals with the cooling system. Air for the engine passes through an oil bath air cleaner and silencer to a chain driven Roots three-lobe blower. The engine has good cold starting qualities due to its high thermal efficiency, and a 12V electrical system is adequate for normal temperatures. The weight is about 1140 lb, and the industrial engine has a maximum torque and brake mean effective pressure of 235 lb/ft and 89 lb per square inch respectively, and develops 77 b.h.p. at 1800 r.p.m.

B. Rhodes and Son, Ltd.

A number of sight flow indicators for pipelines from 1in to 6in bore were shown by B. Rhodes and Son, Ltd., Queen Street, Romford, Essex. These indicators can be supplied in various metals to suit them for use with industrial equipment handling most kinds of liquids.

A typical indicator is the one of flap design illustrated in Fig. 25. In it the flap is placed on the inlet side and a graduated

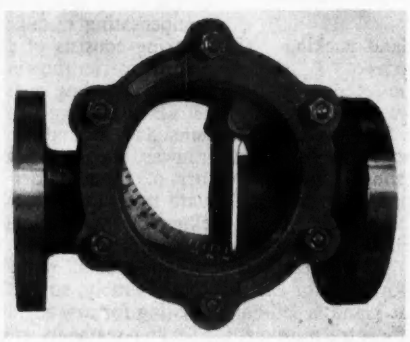


Fig. 25—Flap sight-flow indicator for high-pressure lubricating oil—Rhodes

scale provides a useful indication of variations in flow of the liquid in the pipeline. The flap has a machined face which seats against the inlet port and acts as a non-return valve in the event of back-flow in the line. As in all indicators of this firm's manufacture, heavy flanges hold the toughened, heat-resisting glass discs on each side of the body. These flanges are recessed to prevent the jointing washers blowing out.

In addition to the straight-through indicators such as that illustrated, 90 deg. angle models are made for use where the inlet and outlet lines are at right angles. A 90 deg. "three-view" design with a third sight disc on the top is made for use where an indicator has to be fitted in a line near the floor. With this design light entering the side discs enables the liquid to be seen clearly and conveniently through the top disc.

British Steam Specialties, Ltd.

Among the equipment on the stand of British Steam Specialties, Ltd., was a complete range of "Velan" traps including the bronze radiator trap, the all-forged steel "Navy" trap with built-in by-pass for pressure up to 2500 lb per square inch and 1100 deg. Fah. and the "7 in 1 universal." The latter, of which we reproduce a view in Fig. 27, incorporates an integral strainer, a check valve, air vent, sight glass, thermometer and temperature controller. The heart of the "Velan" trap is the segmental bimetal element, basically of nickel and chrome for corrosion resistance, in which the plates are arranged to parallel the saturated steam curve and operate at close to the steam temperature over a wide pressure range. An adjusting wedge allows for the setting to be altered to obtain planned discharge temperatures. In its lowest position the clearance equals the maximum deflection of the bimetal and the condensate is discharged at close to steam temperature, while in the highest position there is decreased clearance and the discharge temperature of the condensate is low. The strainer is of perforated stainless steel and gives a five to one flow ratio. Under severe conditions the chrome steel self-aligning ball valve, which is ground to a mirror finish, and performs four functions, is air-bubble free and has a stainless steel seat with a "stellited" seating area. A forged bronze cover plate permits ready inspection and maintenance of internal parts and a blow down plug facilitates the flushing of the strainer while the trap is in operation.

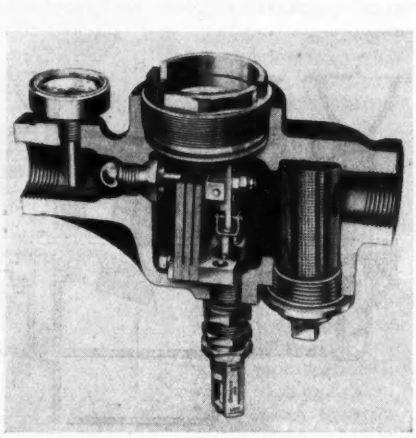


Fig. 27—"Velan" universal steam trap—British Steam Specialties

Mechans, Ltd.

Marine air conditioning systems were displayed by Mechans, Ltd., the office on the stand being air conditioned by the company's "Indivent" system. Also shown were the components of the new "Indivent Miniduct" system, of which a schematic arrangement was on view. This system, which operates on the "Indivent" principle, permits full and individual control of conditions in every cabin and it is noteworthy that the maximum outside diameter of the supply air ducts is 5¼in and that no duct insulation is required.

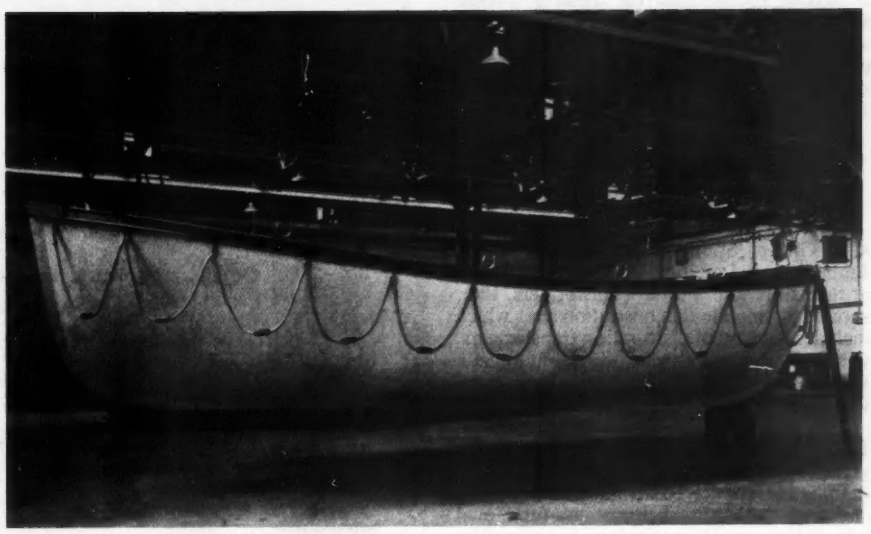


Fig. 26—24ft glass reinforced plastic lifeboat—Mechans

On a separate stand a ship's lifeboat was shown having dimensions of 24ft in length by 8ft beam by 3ft 4in deep and a carrying capacity of 40 persons. This boat, which is illustrated in Fig. 26, demonstrates the use of plastic material in boatbuilding. It is of glass reinforced plastic, moulded entirely in one piece, including thwarts, buoyancy tanks, fuel tanks, etc. It is a class "B" motor lifeboat fitted with an 8/20 h.p. Morris "Vedette" engine and weighs 21 cwt. The hull and other parts are cold formed without pressure and the buoyancy tanks are fitted after the hull is formed with the inner lining still wet, and a sealing coat is applied. Both the food containers and the fresh water tanks have light gauge metal bodies sheathed with plastic and are bonded to the structure as are the thwarts, which are preformed. There is a mahogany gunwale and a teak keel incorporated in the plastic mould, and the boat has been fireproofed by the addition of chemicals to the resin mix. The lifeboat has satisfactorily passed the stringent tests devised by the Ministry of Transport to prove this form of construction and actually carried a 100 per cent overload instead of the normal 25 per cent, and the resultant deflection was within the permissible statutory amount, there being no permanent set.

Atlas Diesel Company, Ltd.

The Atlas Diesel Company, Ltd., Wembley, exhibited amongst its pneumatic tools, a new lightweight grinder and an air hoist fitted with a swivelling suspension

and trolley locking device which is specially designed for marine use. The locking device fitted to the air hoist trolley used in engine rooms prevents the trolley moving as the ship rolls, and the hoist is designed to operate at angles up to 30 deg. These hoists are capable of lifting loads of 5 tons and have an air motor with cylinders arranged in star formation. The starting torque of the motor is independent of the air supply, and it has five adjustments of the lifting speed.

The new grinder weighs only 6 lb and is designed primarily for sanding with a 9in disc, wire brushing and cup wheel grinding. Two types of pad are available for sanding—a flexible rubber pad for dressing curved surfaces, and a semi-flexible pad for synthetic resin bonded discs. When used for cup wheel grinding and wire brushing the machine is fitted with a slightly longer spindle.

Lancashire Dynamo Group

Six companies from the Lancashire Dynamo Group, St. Stephens House, Victoria Embankment, London, S.W.1, were exhibiting at the exhibition. Foster Transformers, Ltd., showed its mobile demonstration unit which includes displays of distribution transformers, voltage and current transformers, automatic voltage regulators and constant-voltage transformers.

The main exhibit shown by Lancashire Dynamo Electronic Products, Ltd., on the group stand, was a simple demonstration of automation applied to an industrial process, showing, with the help of a functional mimic diagram, the operation of a controller for a sugar centrifuge. The demonstration illustrated the flexibility of the electronic control system. The process control unit illustrated in Fig. 28 provides complete control of the operational cycle : it has facilities for setting the acceleration and deceleration rates and spin and plough speeds and for initiating various functions (such as charge, cone lift and water wash) at predetermined times from the start of the process cycle.

The exhibits shown by Lancashire Dynamo and Crypto, Ltd., included a motor from the company's new range of dust-tight and hose-proof machines specially developed for the chemical industry and for explosive filling factories ; examples from the range of motors designed to meet new N.E.M.A. standards and to give interchangeability between 50 c/s and 60 c/s motors; and the partly-wound stator of an 833/445 h.p., 738 588 r.p.m., 3·3kV boiler house fan motor displayed so that the winding details and construction could be studied.

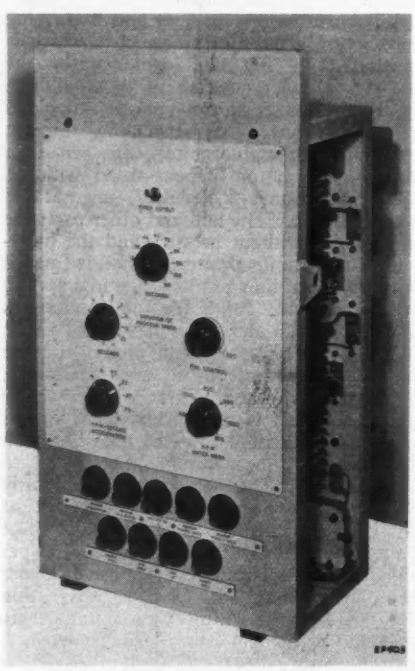


Fig. 28—Typical process control unit for a sugar centrifuge. This unit provides complete control of acceleration and deceleration processes, charge, spin and plough speeds, cone lift and water wash—Lancashire Dynamo

Wellworthy, Ltd.

In addition to a display of the many types and sizes of pistons and piston rings made by Wellworthy, Ltd., of Lymington, this firm also showed a prototype model of the Wellworthy-Ricardo superchargers now undergoing tests in a number of installations. One of the new superchargers is illustrated in Fig. 29, and its construction is shown diagrammatically in Fig. 30.

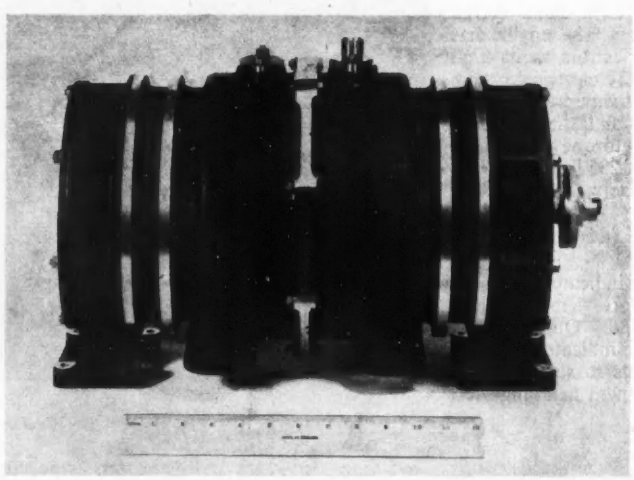


Fig. 29—Prototype " Wellworthy-Ricardo " supercharger—Wellworthy

In the supercharger two groups of cylinders have double-acting pistons actuated by a centrally disposed wobble plate mounted on ball bearings on a driven shaft. Each group of seven cylinders is arranged axially round a single central rotary valve, which controls in turn, both the inlet and delivery, to and from, both ends of each cylinder. Rods carried by centrally disposed oscillating bearing blocks in the wobble plate actuate the pistons, and these piston rods reciprocate in long guides in the body of the supercharger. By the use of long guide bores for the rods the pistons are centralised and do not contact the cylinder walls. The pistons are given a small clearance and sealed by labyrinth grooves, so that there is no need to fit piston rings. Both the cylinders and the pistons are made in light alloy and no liners are fitted. The general operation of the supercharger can be seen from the diagram—as the rotating wobble plate actuates the pistons, slots in the centrally displaced rotating valves open and close ports at the ends of the cylinders to the air inlet and delivery channels.

The makers point out that with this form of construction the clearance volume between the cylinders and valves is very small as the cylinders can be packed closely round the central valves, thus reducing the length of the passage ways. As only one valve is used to control seven double-acting pistons, the amount of pipework is reduced to a minimum, and as neither the pistons nor the rotary valves touch the bores in which they work no lubrication is required. The prototype superchargers weigh about 80 lb and are designed for a swept volume of 3¼ litres, which is suitable for dealing with the range of engines between 5 litres and 9 litres.

Also exhibited on the stand were examples of the firm's new self-compensating metallic gland packing. This packing consists of a series of " L " section cast iron carrier rings in the recess of each of which two sealing rings are carried side by side. Each sealing ring is built of three segments and around the rings there is placed an inwardly contracting spring ring. A number of these carrier-sealing ring assemblies are built up to form the metallic gland packing of the required length.

The carrier rings allow for a small radial movement of each sealing assembly, so that the gland is self-compensating for any slight off-centre movement. Sealing segments are available in cast iron, bronze, tin-aluminium, carbon, &c.

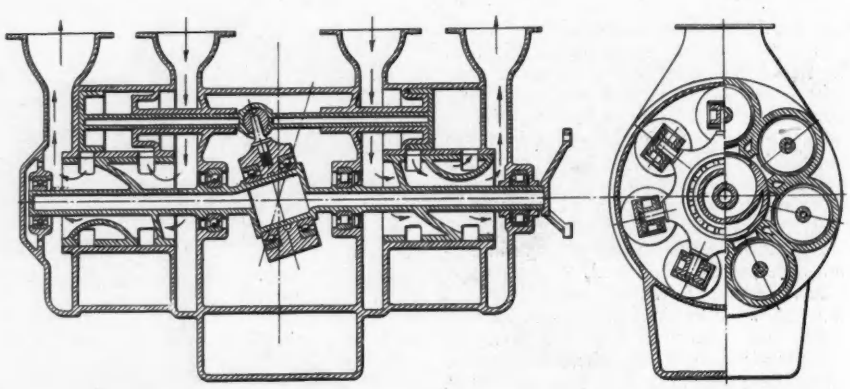


Fig. 30—Diagrammatic arrangement of " Wellworthy-Ricardo " 14-cylinder double acting supercharger—Wellworthy

J. W. JACKMAN and Co., LTD.

An interesting group of moulding machines exhibited by J. W. Jackman and Co., Ltd., Vulcan Works, Manchester, included the "Rota-lift" machine, particularly suitable for use with snap flasks, which we illustrate in Fig. 31. This pneumatically operated machine is made in two sizes with tables of 22in by 26in and 24in by 27in. with respective jolt capacities of 750 lb and 1200 lb and each having a draw of 11½in. Its motions are controlled by valves fitted with knee-pad levers thus leaving the operator's hands free for working. In ramming, the bottom half of the flask is jolted and the top half pressed. The top half is held by pneumatically operated clamps and separated from the pattern plate on the return stroke of the press piston whilst the pattern plate is vibrated. After the bottom half has been rammed the flask is lifted by roll-over arms so that it can be easily rotated on its axis. When the pattern plate has been withdrawn the top half of the mould is swung over the bottom half, which is then raised by the press cylinder into contact with the top half for closing. The flask pins automatically line up in the closing movement, the air clamps are then released and the table is lowered ready for the finished mould to be removed from the machine.

The flask used on this machine is the "Fremont Taper Spreadlock" design, made of magnesium. It has accurately machined inside surfaces and flanges with securely bolted solid corners of robust construction to ensure permanent shape and taper. The opening corners which spread apart are operated by cams and levers, and a corner insert of rubber completely closes the gap so that the sand cannot lodge in the opening.

Another exhibit was a recently introduced portable rock-over jolter in which the ramming of the sand by jolting is effected on one side and the drawing of the pattern from the mould on the other side. After the mould has been rammed, adjustable pneumatic clamps are automatically positioned on the bottom board at the back of the mould to clamp the box for rocking over. The mould is then rolled over to the other side of the machine to the rising pattern draw table which has a double-cylinder draw movement, giving an initial slow and then a quick draw.

A core blowing machine on the stand was shown working in conjunction with a semi-automatic core roll-over and draw machine. After a core has been blown the box is run off the blower table on to the table of the roll-over machine. A drier plate is laid on top of the box and pneumatically operated clamps swing over from each side to lock the box on the table. The table is then rotated through 180 deg. and the core draw mechanism rises. The clamps are then released and the core is withdrawn as the box is vibrated to release the core on its drier plate. Whilst one core is being drawn the next one is being blown on the machine.

Other equipment on the stand included a sand preparing plant, a bench coreblower, a shake-out, a casting ladle, and a hardness tester.

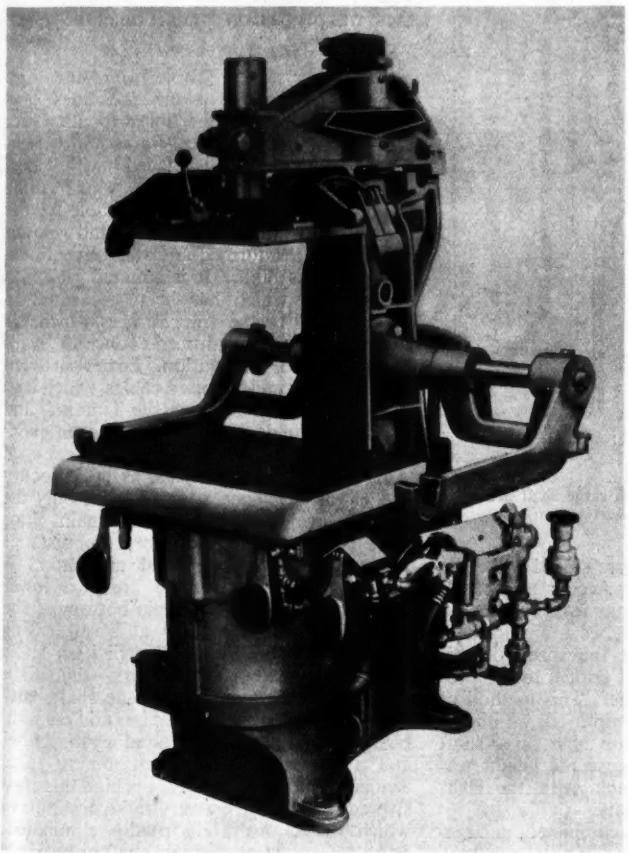


Fig. 31—"Rota-lift" moulding machine for use with snap flasks—Jackman

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD.

General engineering exhibits and arc welding equipment occupied separate stands taken by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17.

On the first stand there was a complete high-pressure cylinder for a 7300 s.h.p. marine turbine (maximum rating 8200 s.h.p.) arranged for feed water heating. It is rated at 7300 s.h.p. at 4810 r.p.m., the steam conditions being 450/430 lb per square inch gauge 750/730 deg. Fah. The high-pressure stages comprise a velocity compounded stage and ten single impulse stages. The stainless steel blading discs are integral with the shaft. Another exhibit showed a 350kW marine auxiliary set, comprising steam turbine and 220V d.c. generator. The steam conditions are 450 lb per square inch gauge, 750 deg. Fah., 28½in Hg. 15in double helical, single reduction gears give a reduction from 6500 r.p.m. to 1000 r.p.m. An oil tank is incorporated in the bed-plate.

The welding exhibits included an automatic arc welding equipment, shown operating as a submerged arc welding machine, but so designed that it can be used either for submerged arc or open arc welding with only slight modification to the welding head. New design improvements provide for increased flexibility in head mountings and ensure a minimum of wear and backlash in the moving parts. A sensitive electronic circuit is incorporated for arc control, initiation of the welding current and control of the travel speed. The flux used in the demonstration is designed specially for single-pass welding at high speeds. Other fluxes are available for heavy gauge and multi-pass welding.

DUNLOP RUBBER COMPANY, LTD.

The design of two new anti-vibration mountings for marine application displayed by Dunlop Rubber Company, Ltd., is based closely on Admiralty specifications and performance requirements. The smaller series "A" mounting for loads from 20 lb to 250 lb, have aluminium bronze metal parts and oil-proofed rubber for sea-going applications. These mountings have a low natural frequency for normal loads, progressive spring rate under overload conditions and decelerator units are incorporated. The larger series "D" mountings, for loads up to 5000 lb, have low natural frequency for normal loads, a maximum deflection of 1·5in under shock loads, and controlled stiffness in vertical and horizontal directions.

Flexible pipes were exhibited for use on machine tools, mechanical handling equipment, and agricultural and earth-moving machinery. These pipes have seamless inner bores from $^{5}/_{32}$in to 2in wide and are available in three ranges suitable for from 600 lb to 6000 lb per square inch working pressures. They can be used to convey air gases, coolants, mineral and vegetable oils, petrol and kerosene, and their ability to absorb vibration, resist chafing and remain flexible to allow for relative movement between components makes the pipes suitable for use in all branches of industry.

NEWTON VICTOR, LTD.

A new industrial X-ray equipment (the first to be designed and manufactured in Great Britain with gas insulation for both X-ray tube and transformer) was shown by Newton Victor, Ltd., 132, Long Acre, London, W.C.2.

The high voltage transformer and the associated transformer for heating the filament of the X-ray tube are both contained in a cylindrical steel tank 18in in diameter. The X-ray tube is directly connected to the high voltage transformer in the same tank but the target or X-ray source is at the end of a small diameter pipe projecting 18in from the main tank. The target extension tube can thus be inserted into hollow castings or the complete transformer tube head can be placed inside pipes and pressure vessels larger than 18in in diameter. The use of sulphur hexafluoride for the insulation of both transformer and X-ray tube keeps the weight to a minimum and at the same time improves reliability by avoiding the problems associated with insulating oils at high temperatures. A metal box arranged for transport houses the controls for voltage and milliampere current with the associated instruments and exposure timer with a range of 0·55 minutes in intervals of one second, together with the usual switches and indicating lamps. A small air cooled water circulator provides a constant flow of water for cooling the X-ray tube target, which is at earth potential, thus making the equipment independent of the qualities and pressure of mains water supplies. For laboratory use a gantry supports the tube head so that it can be quickly and conveniently positioned in relation to the specimen. The tube head can be very easily detached from the gantry when required.

(*To be continued*)

North of Scotland Hydro-Electric Schemes

No. VI—THE TUMMEL-GARRY SCHEME,* PART III

(*Continued from page 378, September 9th*)

Our survey of the Tummel-Garry scheme continues this week with some remarks about the diversion works—tunnels and aqueducts—of the Errochty section. Errochty power station is then described, and details are given of the plant installed and of the electrical layout. Errochty group control centre and substation are also briefly described.

THE aqueducts bringing additional water to the Errochty catchment were shown in Fig. 1 which appeared with Part I of this article. It may be recalled that the principal aqueduct serving Errochty reservoir runs from an intake on the Bruar River, parallel and to the north of the Garry, intercepting various streams. It then veers to the south, crossing the Garry, and passing on to Errochty reservoir. The weir on the River Garry is one of the main hydraulic structures of this collecting system. It consists of a small gravity dam, built in a "V" shape to increase the length, and hence the capacity of its spillway, for sudden and severe floods are experienced on the Garry. In the centre of the stream there is a pier, at the apex of the "V" formed by the weir; it carries a footbridge and incorporates sluice gates controlling a scour culvert passing through the base of the weir. The footbridge spans the river linking the intake tower on the right bank, which controls the tunnel to Errochty reservoir, and the outfall of the aqueduct tunnel on the left bank. Generally the aqueduct consists of partly unlined tunnels, the total length being some 12 miles; it commands 68 square miles of catchment, which is more than two thirds of the total catchment area supplying the reservoir. The aqueducts are proportioned with a capacity equal to five times the mean annual flow; they are thus able to collect about 90 per cent of the run-off.

The Main Power Tunnel

The tunnel from Errochty reservoir to the power station totals 6½ miles in length. The intake works are on the right bank of the reservoir, a short distance from the dam. They comprise the usual gate tower, built of reinforced concrete, with guard gate and control gate, and trash screens. A large sump has been provided at the base of the screens.

The main tunnel between the reservoir and the surge shaft is 29,000ft in length, and is of horse-shoe cross section, concrete-lined with an equivalent diameter of 15ft 6in. The maximum hydrostatic head acting on the tunnel is 330ft. It was driven from the intake and from two adits, giving five working faces. The light Swedish drilling equipment was used for driving it, and a pneumatic concrete placer was used for lining, in conjunction with a 110ft shutter. Weekly rates of progress of 130ft were regularly achieved in the tunnel driving and five cycles of operation with the 110ft shutter were completed weekly when the work was in full swing. This work represented tunnelling which is typical of Scottish hydro-electric work generally, and no exceptional difficulties were encountered.

The surge shaft is shown in Fig. 11. It will be seen that the high level tunnel ends in a vertical shaft, with a circular pressure tunnel below it, a layout similar to that employed on the Affric scheme, and for the same reason, namely that a long steel penstock is avoided and economy in steel achieved. It was also considered that the vertical shaft and pressure tunnel gave a simple layout, more easily constructed than an inclined shaft.

A novel method of construction was used for excavating the surge shaft, which is 600ft in depth. So as to avoid difficulties of timbering and so on, inherent in driving a vertical pilot shaft, a pilot stope was driven, sloping at 60 deg., and spiralling in four successive legs, just inside the line of the circumference of the finished shaft. Two such pilot stopes were driven, connected at intervals by cross

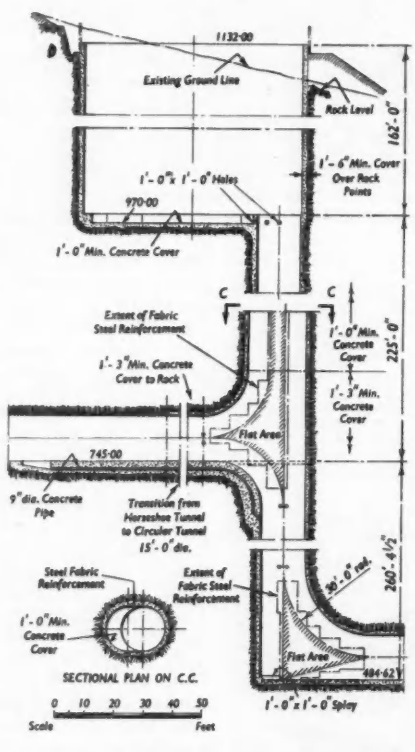


Fig. 11—Cross section through surge shaft and main power tunnels

tunnels in which tools were stored while the work was in progress. Access by the 60 deg. stope was difficult but feasible and the method was economical, we are informed, though rather slow, but the speed of this part of the work was not critical to the progress of the whole scheme. This method of spiral stopes has been employed, we understand, for the construction of a surge shaft in Sweden, but in that case the height was small, and not comparable with the 600ft depth of the Errochty shaft.

With the spiral stopes completed, enlargement to the full size was simple, mucking being done from the lower tunnel. Concreting of the vertical shaft was done with climbing shutters, rather similar to the shutters used for the Fannich shaft, the concreting of which was described in some detail in the third article in this series. The sections of the shaft below and above the main tunnel from the reservoir were each concreted in one continuous operation, lasting eight or ten days, and a similar continuous method was also used for the expansion chamber above the surge shaft. The upper shaft is oval in cross section, with the minor axis equal to the diameter of the circular shaft, so that it has a slightly larger cross-section than the part below it.

The circular pressure tunnel below the pressure shaft is 15ft in diameter and will be subjected to a maximum hydrostatic pressure of 260 lb per square inch; an allowance of 37 lb per square inch above this figure was calculated for hydrodynamic surge and water hammer effects. The tunnel is lined with a minimum of 15in of concrete; it was first grouted at low pressure to fill the voids in the crown, and then grouted in stages radially at pressures up to 375 lb per square inch. The trifurcation at the end of this tunnel is formed in reinforced concrete, with steel "nosing pieces" at the actual points of division, and immediately downstream of this trifurcation, a steel-lined section commences on each tunnel. At this point the rock cover over the tunnels reduces to 280ft, and the steel pipe lines have been designed to withstand successively greater pressures, as the rock cover reduces and the power station is approached, up to the full head near the power station. The steel pipes are 7ft 8in in diameter varying from ¼in to 1¼in in thickness, and are butt welded, with cover straps. The space behind the pipes is packed with concrete and contact grouted. As the head on the pipes is relatively modest, no weld testing was done. The pipes are entirely buried, right up to the turbine inlet valves. A construction adit crossing all of them was plugged on completion of the work.

The Power Station

The power station (Table I *ante* and Figs. 12 and 14) follows along the lines now generally adopted by the Board for its power stations in that it is steel-framed with reinforced concrete walls faced with local stone. The tail-race bridge is also stone faced. The rock here was unsuitable for the construction of an underground power station, we are informed, and so a conventional structure was built. It is situated well into the hillside, which has been excavated to make room for the transformers which are enclosed inside reinforced concrete walls at the back of the station. Power is taken from them by underground cables, which lead to a cable bridge crossing the Tummel, and thence to the large switching station mentioned earlier.

A similar internal layout as at Pitlochry and Clunie has been adopted, with only the exciters projecting above the main floor level. In this case, however, the distance separating the turbines and alternators is relatively large, and there are two lower floors, one at the level of the bottom of the alternators and the other at scroll casing level. The alternators are carried on some heavy reinforced concrete work—there is a conical plinth round the turbine shaft, with heavy reinforced concrete beams and columns connecting it to the surrounding structure, and a substantial floor slab joining these elements together. The idea behind this massive design is to give a very rigid structure in which deflections are virtually eliminated, as no deflections of the main shaft or bearings of the machines can be tolerated. A further requirement is the avoidance of resonant

* No. I: "An Introductory Survey," appeared July 14, 1950; No. II: "The Loch Sloy Project," July 21-August 4, 1950; No. III: "The Fannich Project," June 8–15, 1951; No. IV: "The Mullardoch-Fasnakyle-Affric Project," April 11–25, 1952; No. V: "Some Schemes for Local Supply," October 16–23, 1953.

vibrations in the structure surrounding the machines, and a judicious combination of plinth, beams and columns, and slab provides three basic elements with differing natural frequencies so that vibration in the power station can be kept to a minimum. Most of the electrical auxiliaries are housed on the intermediate floor and the cables serving them are carried in brackets suspended from the ceiling, but the turbine intake valves and the turbine relief valves are on the lowest level. The design is such that only the lower 49ft 6in and accommodates not only the generating sets but also the rotary inlet valves which are immediately on the end of the welded plate steel spiral casings. The overhead travelling crane has a span of 36ft; the main and auxiliary hoists are 95 tons and 10 tons respectively, with a clear lift of 40ft.

The three generating sets installed each consist of a vertical Francis turbine with stainless steel runner, which drives a two-bearing alternator giving 27,750kVA (at 0·9 power factor) under a net head of 525ft. The normal range of turbine net heads at full station load of 75 MW is 525ft to 569ft. Each turbine has a pressure relief valve automatically controlled by the governor, which limits the pressure rise at the spiral casing inlet to 19 and 25 per cent when throwing off 100 per cent continuous maximum load on one or two units respectively. Draught tube liners of steel plate are provided.

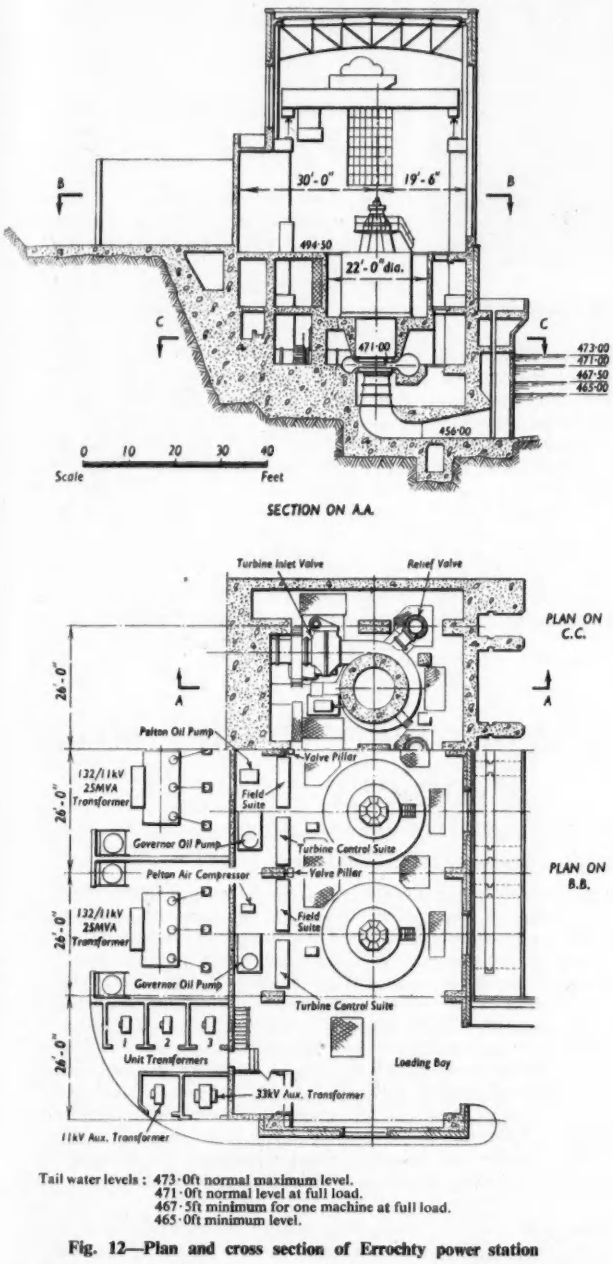
The alternator and the direct-driven main and pilot exciters are totally enclosed and ventilated by a fan on each end of the rotor. Part of the circulating air can by-pass the air coolers and be discharged through hand-operated louvres to warm the alternator reservoir. An idler valve by-passes the oil into a sump when the pressure in the reservoir is normal. With any two pumps running the three generating sets can be maintained in service, but one stand-by oil pump is provided; this is interchangeable with the three governor oil pumps and is driven by a Pelton wheel, with an automatically-operated inlet valve, which takes water from the upstream side of one of the main turbine valves; this set has no oil pressure reservoir. There is a standby air compressor driven by a Pelton wheel with a hand-operated inlet valve.

The bearing oil system consists of a common sump, a pump driven by an induction motor fed from the unit switchboard and two oil coolers of which one is a standby. A duplicate pump is provided as a standby; its induction motor is fed from the common services board.

For each generating set the cooling water supplied to the alternator air cooler, the bearing oil coolers and the governor oil cooler is lifted from the tail-race by an electrically-driven pump. A fourth pump is a standby.

A dewatering pump enables the draught tube outlets to be emptied one at a time after being sealed by stop-logs. A sump for leakage or drainage water is provided with a floatless water-level controlled drainage pump.

Fig. 13 shows the main electrical connections of the station. The three step-up generator transformers of ratio 132/11kV are on the upstream side of the power station; they are oil-immersed and forced-air-cooled and are designed for the addition of remote electrically-controlled on-load tap changing gear. There are two propeller fan air blowers for each transformer. The 132kV bushings are of the anti-fog, oil filled, condenser type; the L.V. side is connected by cable boxes. Auxiliary transformers are provided as follows: one,



Tail water levels: 473·0ft normal maximum level.
471·0ft normal level at full load.
467·5ft minimum for one machine at full load.
465·0ft minimum level.

Fig. 12—Plan and cross section of Errochty power station

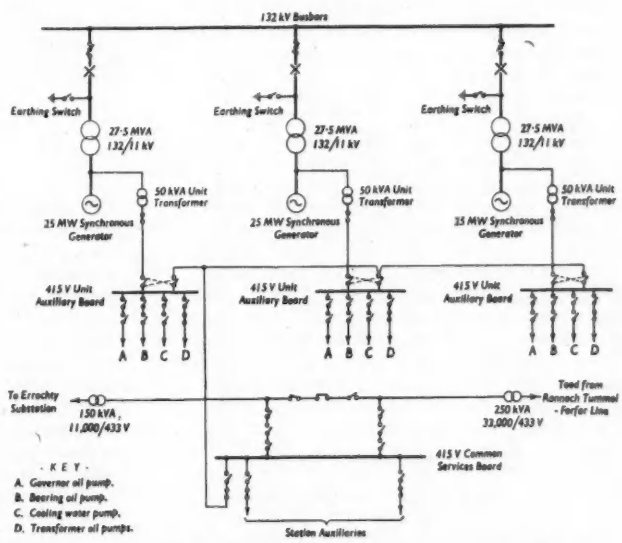

132 kV Busbars
Earthing Switch
27·5 MVA 132/11 kV
50 kVA Unit Transformer
25 MW Synchronous Generator
415 V Unit Auxiliary Board
A B C D
To Errochty Substation
150 kVA, 11,000/433 V
250 kVA 33,000/433 V
Feed from Rannoch Tunnel - Forfar Line
415 V Common Services Board
- K E Y -
A. Governor oil pump.
B. Bearing oil pump.
C. Cooling water pump.
D. Transformer oil pumps.
Station Auxiliaries

Fig. 13—Principal electrical connections at Errochty power station

half of each scroll casing is embedded in concrete, the upper part projecting above the floor level.

When the three machines are working at the full rated load of 75MW, the flow of water through the station will vary between 1770 cusecs and 2200 cusecs, according to the head, the latter figure corresponding to a net head of 525ft.

Power Station Plant

The power station is laid out with four bays, each of 26ft with an extension at each end; the total length is 125ft. The width is room. Make-up air is taken from the room through grid covered openings with filters. Electric heaters are placed in suitable positions to prevent condensation on the alternator and exciters when a set is out of commission.

The governor actuator is operated from a permanent magnet generator fitted on the top of the exciter shaft. For each governor there is an electrically-driven oil-pressure pump with automatic starter which delivers into a pressure reservoir fitted with an automatic air compressor actuated by oil pressure to maintain the correct oil level in the

ratio 33,000/433 250kVA; one, ratio 11,000/433 150kVA; and three, ratio 11,000/415 50kVA. The 250kVA and 150kVA machines are alternative supplies to the common services board and the 50kVA transformers are unit transformers. The main generator transformers are connected to the substation by 132kV oil-filled cables.

The station is designed to be remotely controlled from Errochty group control centre, which is situated in Errochty substation about 400 yards distant on the other side of the river. The machines are started and stopped by push buttons in the group control

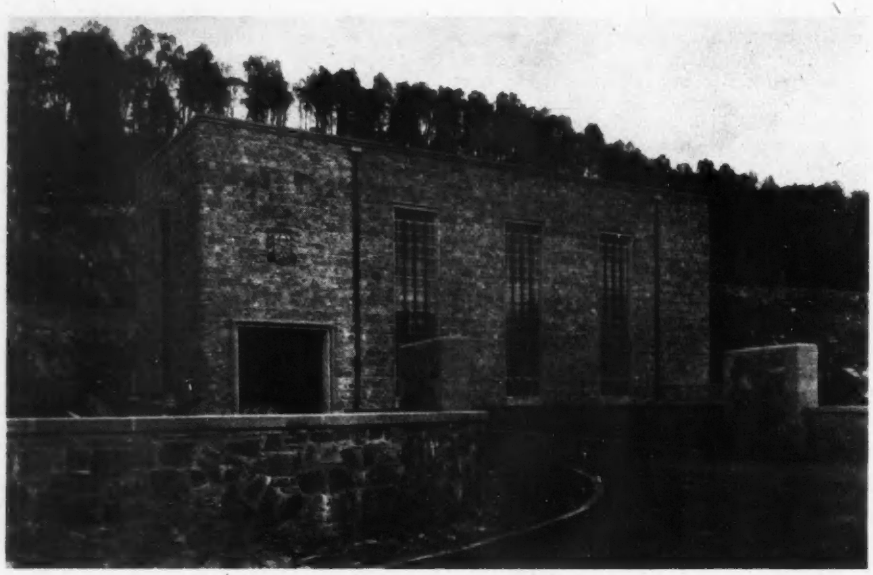


Fig. 14—Errochty power station. The masonry facing is shown to advantage in this illustration

room, which will run them to the " ready to synchronise " condition, when a signal is displayed in the control room. Synchronising and control of voltage and load can then be carried out from the control room. Alternatively, local manual or automatic control can be performed in the power station. Alarm equipment is provided on each machine, giving full indication of the various alarm conditions. Composite grouped alarms are transmitted for display at the group control centre.

Errochty Dam Compensation Water Set

A turbine-driven induction generator is installed ¾-mile downstream from the dam to make use of the compensation water which must be continually passed down the Errochty Burn. The set consists of a horizontal-shaft 30in diameter " Turgo " impulse wheel giving about 700 b.h.p. at 434 r.p.m. from 28 cusecs under a net head of 265ft. The nozzle and spear head are bronze and the spear rod is stainless steel. The inlet sluice valve is 21in bore. The induction generator is rated at 550kW with a generating voltage of 415.

A 1200A air circuit breaker supplies a 750kVA transformer of ratio 33/0·415kV with the output of the compensation water set. Supplies to the dam are given through switch fuses from 400A busbars and a 50kVA, 33/0·433kV, pole-mounted transformer; they include the feeds to the draw-off energy gate, the needle valve, the compressor for the pneumatic reservoir level recorder, the level transmitter, lighting and heating. The same transformer gives supplies at the intake, to the emergency intake gate, main intake gate, trash rack, lighting and heating. Both transformers are connected to the Tummel-Spey Valley 33kV line.

Errochty Group Control Centre

Errochty group control centre, in addition to acting as the load despatching centre for the Tummel-Garry group of stations, controls Errochty power station and substation by light current direct wire equipment, and Tummel power station and substations by supervisory equipment. The other stations in the group are continuously indicated together with the total generated load of each station. Two load transfer substations to the North of Scotland Hydro-Electric Board and the South of Scotland Electricity Board are also supervised, namely Abernethy, which is controlled by supervisory equipment, and Bonnybridge which is indicated by supervisory equipment. The total load transfers in megawatts and reactive megavoltamperes at both these substations are indicated and recorded at the group control centre.

At Abernethy substation, Bonnybridge substation, Clunie, Pitlochry and Rannoch power stations the supervisory systems operate on to a two-tone voice-frequency telegraph installation, which in turn is applied to the power line carrier equipment superimposed on the 132kV lines. Errochty and Tummel power stations operate over underground pilots.

The main diagram panel is of cubicle type with single aspect, three lamp indicators for circuit breaker and isolator positions. The control desk houses the control panels for the three Errochty machines and the two Tummel bridge machines and also the control facilities for Dunalastair dam and aqueduct gates and Kinlochrannoch weir. Duplicate private branch exchange telephones provided on the desk are connected to the North of Scotland Hydro-Electric Board's main communication system. The main hydraulic diagram panel gives a complete pictorial representation of the whole of the Tummel-Garry area with indications of water level and total generated loads at key points.

Errochty Substation

The Errochty substation, as we have already noted, is a major junction in the Highland grid. Power is fed into the grid here from the cables from Errochty power station, from Clunie and Pitlochry along a 132kV line, and from the Tummel, Rannoch and Gaur stations at 132kV. The Gaur scheme is also connected through a 33kV distribution system supplied from Rannoch. A 132kV line joins the station from the north, where power is supplied from various other hydro-electric developments, and four transmission lines join the station with Central Scotland, one pair going direct to Bonnybridge in the South of Scotland Electricity Board's area and the other pair to Abernethy, linking up again with Bonnybridge and the Board's distribution network in Perth and Angus. There is also a line between Errochty and Sloy.

(*To be continued*)

America's Approach to the Road Problem

By W. H. GLANVILLE* and R. L. MOORE†

No. III—(*Concluded from page 366, September 9th*)

This article has been prepared following a visit to the United States in October and November, 1954. An outline is given of the new road development plan for America, then in preparation, in which it is proposed to increase the 5 billion dollars at present being spent annually on new roads to 10 billion dollars, over ten years, in order to bring roads up to standards which will be adequate for the increasing traffic requirements of the next twenty years. The article outlines the means by which the estimates were obtained. The backbone of the new plan is a 40,000-mile trunk road network called the "Interstate System." The major road problem of the United States is the provision of adequate urban roads and parking spaces. The article shows how the design of cities is influenced by building all the roads the private motorist wants. On the subject of road safety some of the preliminary results of investigations into ways of reducing the severity of injury to occupants of motor vehicles are given. Some possible reasons are put forward for the better discipline and the decreasing liability to accidents of American pedestrians.

Crash-Injury Research

IN the United States about 75 per cent of all road deaths are those of motor vehicle occupants ; in the United Kingdom the corresponding figure is about 20 per cent. The safety of the vehicle occupant in a collision is therefore a very important consideration and research is being carried out at a number of places. The armed services are particularly concerned at the very considerable wastage in manpower as a result of off-duty road accidents. For example, in 1953, 630 naval and marine corps men were killed while driving, most of these accidents taking place while men were on leave. In the air force there were 938 fatalities during the same period. There were about 1000 men off duty every day in each of these two armed services as a result of traffic accidents. This tremendous loss of manpower, the next most serious after battle casualties, has prompted the Armed Forces Epidemiological Board to set up a commission on accidental trauma, which is financing a variety of researches into crash injury and safe vehicle operation.[22] The following researches sponsored by the commission are in progress :—

Human Factors in the Design and Operation of Motor Vehicles.—This subject includes work on the layout of seat and controls in a

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† Traffic and Safety Division, Road Research Laboratory.

vehicle ; human body size data related to vehicle design ; the visual field from the driver's seat.

Personal Factors in Safe Driving.—At Colorado University, under the direction of Herbert G. Gaskill, efforts are being made to identify and "modify" accident-prone drivers by a study of their social and psychiatric background. Part of this investigation is being carried out by means of a survey of service personnel. A large number of students are also being tested and it is intended to follow their driving accident record over a number of years. Analytical and mathematical studies of the causation of accidents are being undertaken by the private research organisation Jack Dunlap and Associates Inc.[23] Their analysis is based on data obtained from the New Jersey Turnpike authority. It is supposed that accidents result from a combination of two causes : exposure to risk of accident, determined mainly by traffic density and the environment, and risk acceptance, determined mainly by the driver. They claim to show that the daytime single-vehicle accident rate (accidents per unit distance per unit time) varies linearly with traffic density, but there is a discontinuity in the curve for multiple car accidents, a peak occurring at about 100 cars per hour. An attempt is made to explain this on the basis of the variability of risk-taking by drivers and its dependence on traffic density.

Fig. 11—A car prepared for crash investigation by the Institute of Transportation and Traffic Engineering. It is painted white with black marks to help photographic analysis

The Injuries Sustained by Vehicle Occupants in Collision.—Until recently, in the United States, as in this country, the study of accidents has been confined to the analysis of statistical data ; there is little information on the factors causing injury. This gap in knowledge is being filled by several research teams in the United States.

The work of the Automotive Crash Injury Research Project of the Cornell University Medical College, New York, under the direction of John O. Moore,[24] is sponsored by the commission. This work, previously under the direction of Hugh de Haven, is carried out with the assistance of the State police forces of Indiana and Maryland and the North Carolina State Highway Authority. These organisations send trained teams of accident investigators to make detailed studies of a proportion of the accidents occurring in their area. The investigators record detailed medical information, damage to the vehicle, estimate speeds and make a photographic record of the accident scene. Supporting bits of evidence, such as reports of blood spots, tufts of hair, or bits of flesh found on injury-producing objects, are all used to build up as accurate a description of the mechanics of the accident as possible.[25]

The main results[26] arising from this work are as follows :—

(1) Only 24 per cent of fatal passenger car accidents in rural districts of Indiana were so hopelessly severe as to be reckoned as "non-survivable" or "possibly non-survivable." In the remaining 66 per cent of fatal accidents other people in the same car were either uninjured or did not sustain serious injury. In these cases the severity of the vehicle impact alone did not kill people. About half of the fatal accidents took place when vehicle speeds were less than 40 m.p.h. a speed at which stunt drivers can crash cars without injury.

(2) The opening of front doors of cars in accidents where an occupant is killed or injured is a common occurrence. This happens in 72 per cent of fatal accidents and 44 per cent of all injury accidents.

(3) When front doors opened in accidents one out of every three occupants was completely ejected from the car.

(4) Although high impact severity increased the risk of doors opening (62 per cent for frontal impacts) in a number of cases doors opened at low speeds (28 per cent for front impact speeds 0 to 39 m.p.h.). Complete ejection through a door doubled the risk of moderate, severe and fatal injury.

A number of investigations are in progress or planned on the physics of a motor vehicle collision. The work of Colonel John P. Stapp on the human tolerance limits of deceleration are well known.[27] Colonel Stapp has subjected himself to decelerations of the order of 30*g* by means of his rocket-powered vehicle, which can be suddenly stopped when travelling at high speed. This work was primarily of importance for ejection-seat design for aircraft, but the seriousness of the road accident situation in the Air Force has resulted in this work forming the beginning of an extensive research into the mechanics of vehicle collisions. It is proposed to crash all varieties of service vehicles into barriers in order to find out if additional protection can increase the safety of occupants.

Fig. 12—The dummy man used in the I.T.T.E. tests. Cavities in the head and chest contain gauges for recording the accelerations experienced in the crash

A number of researches are in progress which are sponsored by other agencies. At the Institute of Transportation and Traffic Engineering of the University of California,[28] under the direction of Professor J. H. Mathewson, the physics of automobile collision are being investigated experimentally (Figs. 11 and 12). Similar work is being carried out at the Cornell Aeronautical Laboratory, Inc., at Buffalo, N.Y.,[29] under the direction of Edward R. Dye. In both these researches passenger cars carrying dummy people are propelled into barriers and the kinetics of the movement of vehicles and "passengers" studied by high-speed cinematography. Experiments by Herman P. Roth[30] have shown that in a head-on collision between two cars travelling at 40 m.p.h. the front of the vehicles crushed to such an extent that the peak deceleration was only of the order of 15*g*. There was a total crushing of the vehicles of about 6ft, an average dissipation of energy of about 4000 h.p. and a coefficient of restitution of about 0·1. Such decelerations were readily withstood by the drivers of the vehicles, who, at the moment of impact, placed themselves behind the front seats and decelerated with the vehicle. In a road accident the vehicle occupants travel at the original vehicle speed until they hit some part of the vehicle. They are then violently decelerated (say, 100–300*g*) and therefore liable to serious injury. The effect of safety belts for vehicle occupants has been investigated by both these laboratories. At the I.T.T.E. the experiments on the movement of vehicle occupants in a crash have shown the need for restraining the body at the top and a chest belt is advocated.[31] At the Cornell Aeronautical Laboratory, where experiments were carried out on full-sized dummies, but of reduced weight, the movement in a crash was found to be upwards as well as forwards, and this laboratory recommend the fitting of an aeroplane-type safety belt. Car safety belts are now readily available in America and are featured in women's magazines,[32] particularly as a safety device for children.

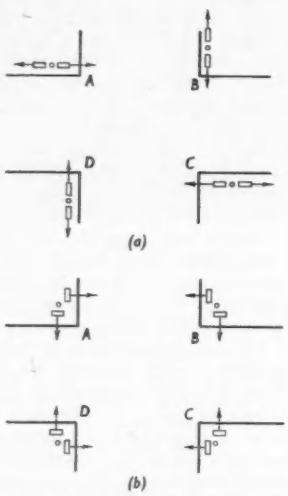
Crash Helmets

Work on crash helmets is being carried out by Protection, Inc., Los Angeles[33] and by the Cornell Aeronautical Laboratories. Our attention was drawn by Professor Zuckerman to the work of Drs. Lombard and Roth, of Protection Incorporated, who are engaged in the design and manufacture of high-quality made-to-measure protective helmets for test pilots. Their helmet has a glass fibre outer shell, an energy-absorbent lining of foamed cellulose acetate with an inner coating of sponge rubber for comfort. Each helmet is made to fit the individual wearer exactly by casting a replica of his head and moulding the helmet to fit. It was gratifying to find that the conclusions on helmet design, i.e. hard outer shell, thick layer of stiff padding, reached by the Road Research Laboratory were very similar to those of Protection Incorporated. The Cornell Aeronautical

Laboratory has developed a helmet for a sports firm which is said to give very satisfactory results when used by footballers. In this case the expected severity of impact is likely to be less than in a road accident and the helmet padding material must be able to stand repeated impacts without breaking up. These considerations lead to a rather different helmet design from the motor cyclist pattern.

Vehicle Headlamps

The work of the General Electric Company's research laboratories on the production of a new standard sealed-beam headlamp was inspected as well as the facilities



(*a*) A pedestrian standing at "A" cannot see lights at "B" and usually not those at "C" on account of the visors restricting the visibility of the lamp. Lights at "D" are invisible and it is therefore, preferable to walk on the right-hand pavement. There is no requirement for turning traffic to give priority to the pedestrian.
(*b*) A pedestrian standing at "A," "B," "C," or "D" can see clearly a light on the opposite side of the road and can walk when the green light shows, knowing that turning traffic will give way.

Fig. 13—Typical British and American arrangement of signals at an intersection

for testing all types of vehicle lights at the Institute of Transportation and Traffic Engineering, California. The new headlamp, which is not yet fitted to American vehicles because of legal difficulties in certain States, has been specially designed to increase the seeing distance when the meeting or dipped beam is in use. The lens of the lamp has also been improved so that less stray light is sent upwards, and it can therefore be used successfully as a fog light. Calculations carried out by the Road Research Laboratory have shown that this lamp gives excellent visibility in the nearside lane when meeting a vehicle similarly equipped, seeing distances being some 20 per cent greater than with lamps of British design.

There is no interest in America at present in polarised light. The system using polarised light which has been proposed there is designed to give the same open-road seeing distance as the present sealed-beam lamp. To achieve this a large increase in headlamp power is necessary and the total cost per vehicle of larger generator, bigger lamps, &c., would be about 100 dollars. A person buying a new car would not find his own seeing in any way improved by his own polarised beams and the benefit would only come when most drivers had polarised beams. This, it is believed, may take several years, and the American who buys a new car a year will have to pay a considerable sum before he himself finds much benefit from his extra annual outlay of 100 dollars. This attitude towards polarised headlighting system in America to-day explains why manufacturers of vehicles are uninterested in a system apparently possessing such promise, a promise which is better than in Great Britain, where a great number of cyclists are an added complication.

Pedestrian Behaviour

There is a marked difference in the behaviour pattern of pedestrians in the United States and in the United Kingdom. The usual rectangular arrangement of streets in American towns results in regularly-spaced intersections, each controlled by a traffic light. The average distance between these intersections is 300ft or 400ft, and it is noticeable that pedestrians usually cross at the traffic lights; moreover the majority of them move across the road in conformity with the light signals. The reasons for this were examined and it was seen that the arrangement of traffic signals is different in America, and it is this which appears to encourage proper behaviour (Fig. 13). From whichever corner of an intersection one stands one faces a signal on the opposite side of the road which can be clearly seen. In England it is rarely possible to do this when walking on the left-hand pavement and not always possible when one is walking on the right-hand pavement (Fig. 13). Coupled with this ease of seeing signals in America is a regulation which requires drivers who are turning to give way to pedestrians who are proceeding with the lights. Fig. 14 shows a group of pedestrians in San Francisco obediently waiting for lights to change before crossing the road. The system is, however, not so simple as the British one from the point of view of the driver. It will be seen that the pedestrian crossing place is outlined by white lines, and it is in this area that a pedestrian has priority over turning traffic. If turning traffic is heavy and there is a large number of pedestrians, an "all-red phase" of the traffic lights is arranged. Large illuminated "walk" signs inform pedestrians that they may cross, and they may do this in any direction they please, diagonally or straight across. This procedure is sometimes called "The Barnes Dance," after its originator, Henry Barnes, traffic engineer of Baltimore.

A comparison of American and United Kingdom pedestrian accident records is of some interest in this connection. If the number of accidents in which a pedestrian is killed is studied year by year it will be seen that the number of such accidents has been falling, since the war, more rapidly in America than here (Fig. 15).

Driver Training in High Schools

The first High School driver training course started in the United States as long ago as 1933. The Association of Casualty and Surety Companies and the Automobile Association of America have for many years sponsored school driver-instruction, with the result that in 1953–54, 900,000 students were enrolled in driver education courses in some 10,000 public high schools. Two kinds of training are given, class-room instruction and behind-the-wheel training. About 7000 schools possess a dual control car and in a typical course each student has about eight hours' driving, covering a distance of 70

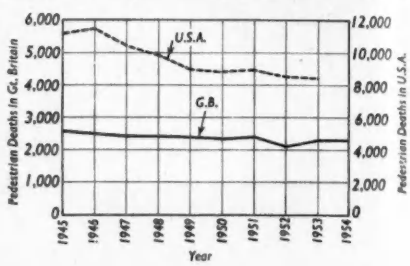


Fig. 15—A comparison of the number of pedestrians killed each year in road accidents since the war in Great Britain and the United States of America

miles. Students are also given about thirty-six hours' class-room instruction and eighteen hours' observation in a car at a cost, for the whole course, of about 30 dollars per student. The A.A.A. publish very comprehensive text-books[34] and graded tests which help to maintain uniformity of instruction. Some 200 training colleges have special training courses for teachers in driving instruction. A number of investigators have followed the accident records of equal-sized groups of pupils which have and which have not received driver training at school. It is known that boy drivers usually have more accidents per year than girls and some of these investigations are invalid because the respective numbers of girls and boys in the comparison groups are not the same. The

Fig. 14—Pedestrians waiting for the lights at Union Square, San Francisco

general conclusion drawn from these investigations is that high school driver training reduces both the accident rate and the numbers of convictions for driving offences.

Conclusions

In comparing American and British experience in road planning and road safety the following points were noted :

In Great Britain it would be of interest to make an overall assessment of the arrears in road construction, by comparing the capital investment in roads and gross national product as has been done in America.

The American attitude towards the expenditure of money on roads is conditioned by arguments based on cost/betterment ratios which take fully into account the savings in time, wear and tear, and petrol, together with savings on accidents. From an overall national point of view such a procedure is the only rational one and yet it is not generally accepted in Great Britain.

The elimination of cross-roads and their replacement by under or over-passes on new American roads, though initially expensive, has a very beneficial effect on road capacity and accident experience. This principle might be considered more frequently in the building of new roads and the reconstruction of old ones in Great Britain.

It has been found that the American motorist is prepared to pay considerable sums to use a safe and fast motor road and to park his vehicle near the city centre, and that, therefore, toll roads and multi-storey parking garages pay their way. The attitude of the British motorist to special charges for greatly improved amenities is unknown ; it might be worthwhile to attempt to find what his attitude would be.

The important results being obtained from crash-injury investigations might well lead to advances in vehicle design which would save life and limb. Rather than wait for American advances it might be more profitable, with our different conditions, to start similar investigations in Great Britain.

The courses of driver training in American high schools and the driver-instructor courses in training colleges are very popular and are making for greater safety on American roads. The adoption of similar schemes in Great Britain is worth consideration.

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Symposium on Corrosion.—A symposium on corrosion is to be presented at the University of Melbourne from November 28th to December 2nd.

Development and Future of Turbine Engines for Airline Aircraft

By J. D. PEARSON*

On September 12th, in the Technological University at Delft, the first Albert Plesman Memorial Lecture was read. The lecturer dealt first with the early history of the propeller turbine, describing an ingenious ducted fan design of 1940, *and then outlined the development of the "Dart" engine. The remainder of the lecture we abstract below.*

Performance Development of Existing Engines

Propeller Turbines.—Fortunately the propeller turbine lends itself very well to continued performance development. This is due to its shaft horsepower being the difference between the power developed by the turbines and the power required to drive the compressor, with the result that any gain in efficiency of these components is multiplied when expressed as a percentage increase in shaft horsepower or decrease in specific fuel consumption.

As an example, the "Dart" turbines develop approximately 4500 h.p., the compressor takes 3000 h.p., and the difference of 1500 h.p. appears at the shaft. This means that 1 per cent improvement in turbine efficiency leads to a 3 per cent increase in shaft horsepower and a 3 per cent decrease in specific consumption, and that a 1 per cent improvement in compressor efficiency leads to a 2 per cent increase in shaft horsepower and a 2 per cent decrease in specific consumption.

Apart from improving the power and reducing the specific consumption by improved efficiency of the components, improvements can be effected by raising the cycle temperature. In general both tend to be done concurrently and as an example Fig. 1 shows what has been done with the "Dart."

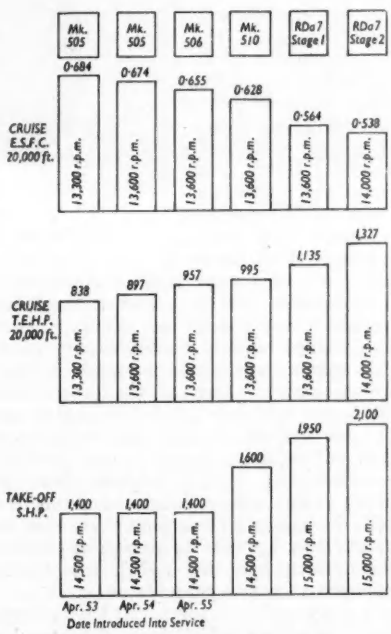

Fig. 1—Performance development

There is obviously a limit beyond which it will be very difficult to improve component efficiencies, but there is more scope for developing the engines to operate at higher temperatures.

The reward obtained for a particular engine design by being able to operate at higher flame temperatures is shown in Fig. 2.

There is little doubt that the intensive development now proceeding on air-cooled turbine blades and air-cooled nozzle guide vanes will lead to continuous performance development of existing propeller turbine engines for some considerable time to come.

All this illustrates that any given design of propeller turbine engine has within it possibilities for development to greater powers and better specific consumption, as has been illustrated by the progress already made with the "Dart."

Jet Engines.—The picture for the performance development of existing jet propulsion engines is rather different. Although the thermodynamic efficiency of the cycle still increases with increasing temperature, this is more than offset by the decreasing propulsive efficiency of the jet. Thus, with the simple jet engine the optimum specific fuel consumption is obtained at a much lower flame temperature at subsonic forward speeds than that at which the engine must be designed to obtain a good thrust/weight ratio.

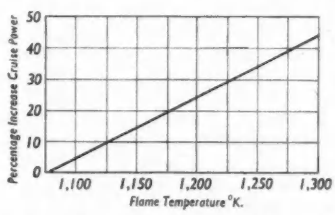

Fig. 2—The effect of flame temperatures on cruise power

This means that the specific consumption of the jet engine cannot be improved by developing the engine to use increased flame temperature. This still leaves open the possibility of improving specific consumption by improved efficiency of components and by raising the compression ratio. The latter can be accomplished either by adding stages to the front or the rear of the compressor. If to the front, then the mass flow is raised at the same time as the compression ratio ; if to the rear only the compression ratio is increased.

On a particular engine which has been developed as a military engine to give the maximum possible thrust, the specific fuel consumption has been reduced by 8 per cent by these methods.

The by-pass engine is a sort of "halfway house" between the propeller turbine and the straight jet engine, and, in fact, it comes into existence as an attempt to counteract the falling propulsive efficiency with increasing temperature of the straight jet engine. Here the optimum temperature for best specific fuel consumption is higher than on the straight jet engine, but is dependent on the by-pass ratio.

It has the ability to take advantage of the higher cycle efficiency by operating at a

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higher turbine inlet temperature, combined with an improved propulsive efficiency derived from a lower jet pipe temperature. This gives the by-pass engine its advantage in specific fuel consumption over the straight jet engine.

Some Technical Considerations

Reverse Thrust.—With a piston engine it is necessary to reverse the pitch of the propeller and run the engine to obtain significant drag. A single-shaft propeller turbine handles a large amount of excess air (six times as much air as a piston engine with the same power) and so has a large pumping power consumption. Thus, by allowing the propeller to windmill and drive the compressor a very considerable amount of drag is available. This is what happens on the "Dart," which provides a significant reverse thrust during the high-speed part of the landing run, but, of course, provides but little reverse thrust when the aircraft slows down. However, it appears to represent a reasonable solution for aircraft of the size powered by the "Dart." With two-shaft propeller turbines, in which the propeller is connected to only one of the shafts, the drag available is reduced and this type of engine will require a reversing propeller, thus following present piston engine practice.

On the jet engine reverse thrust can only be obtained by physically deflecting the jet into a forward direction. It is not necessary to obtain full reversal and, in fact, this would be undesirable as the engine would tend to breathe its own exhaust gases. It would seem that 45 deg. reversal would be quite adequate, as this permits up to 70 per cent of the rated engine thrust to be obtained in reverse. To effect the change of direction of the exhaust gases, some substantial mechanism is required as the forces involved are quite considerable, and this is not achieved without a weight penalty.

The use of adjustable reverse thrust opens up some interesting possibilities as it should enable the engine to be run at full revolutions per minute so as to provide the maximum services for anti-icing and flap blowing and at the same time control the net thrust on the aircraft by means of adjusting the reversing nozzle. Such an arrangement also opens up the possibility of making a landing approach with all engines running at full power, so that if the aircraft has to go round again full forward thrust is available instantaneously by merely moving the reverse thrust eyelids and without having to wait for the engines to accelerate. The possible uses of such a system on military aircraft are obvious, and this development is going ahead. I believe that it is close to being an essential feature for the operation of large jet aircraft.

Increasing Complication.—The operator, in his natural desire for simplification in the engine, is, in my view, doomed to disappointment, as Nature shows us that improved adaptation to the environment leads to complication. This is certainly true of the turbine engine.

In order to get improved consumption higher compression ratios must be used, and to obtain these at reasonable compressor efficiencies it has been necessary to desert the relatively simple centrifugal compressor for the axial compressor and then to go to a two-shaft type of design to get satisfactorily up to the highest compression ratios.

On the turbine side the demands of increasing efficiency have led to multi-stage turbines. The various sealing arrangements through the engine have become increasingly complicated in the interests of reducing leakage losses and thus improving specific consumption.

On the fuel system side a successful rearguard action is at the moment being fought against further complication by the introduction of "black boxes" interposed between the pilot's lever and the engine and propeller, but eventually some sort of compromise may have to be incorporated even on this.

We at Rolls-Royce often look back with incredulity to the time when the "Derwent" engine was designed in two months and running five months after the design began. We sometimes think we have got less clever and work less hard, but the facts are that we are now talking about engines which are so different from the simple "Derwent" jet engine that they are effectively engines of an entirely different sort. As a simple example of this unfortunate but inevitable process the "Derwent" engine had 9000 parts, the "Dart" 12,000 and the "RB.109" 20,000. Basically this increased complication has been forced on us by our endeavour to make the engine meet more suitably the requirements of its environment in the aeroplane, in particular the requirements of better fuel consumption, less frontal area and less weight.

Fig. 3, which shows the "Dart" and the "RB.109" side by side to the same scale, is an interesting example of the rapid progress of design. The "RB.109" will give very nearly three times the horsepower that the "Dart" gave when it first went into service, although of the same overall diameter and weighing only 50 per cent more.

Power and Revolutions Per Minute.—The piston engine seemed, by nature, to have a happy relationship between power and revolutions per minute at take-off, climb and cruise, which suited the speeds of the aircraft to which they were fitted, at least until quite recently, and gave a combination of acceptable durability and a reasonable propeller tip speed for cruise. These relationships require re-examination as aircraft speeds increase on propeller turbine-driven aircraft. One of the fundamental differences between the piston engine and the gas turbine is that the compression ratio of the latter, which is still the basic factor affecting fuel consumption, falls with falling engine r.p.m., with the result that from the engine efficiency point of view the cruise r.p.m. wants to be as high as possible. This unfortunately cuts right across the requirements for low propeller noise.

In this connection some tests have recently been carried out which have demonstrated that propeller noise is a rapidly increasing function of helical Mach number, which merely makes the problem more difficult for fast propeller driven aircraft.

First of all, strenuous efforts must be made in the design of the engine to obtain the maximum possible spread in revolutions per minute between take-off and cruise without sacrificing specific consumption. The best that can be done at present in this direction will not give as big a spread in revolutions per minute as normally exists on piston engines, unless a free power turbine is used, but this has other disadvantages for high compression engines.

If a reduction gear ratio and propeller diameter are chosen to give what is considered an acceptable helical tip Mach number from the noise point of view, then compared with present day piston engine practice the propeller will be turning too slowly for take-off. Fortunately, the requirements of high forward speed lead to engines of a power which, by piston engine standards, give excess power for take-off. This means that in aircraft which cruise at high speed there will always be plenty of horsepower available for take-off.

The limitation in take-off thrust will then be in the propeller itself, because at a given revolutions per minute a given propeller can only usefully use so much horsepower. Thus, the engine designer will then be brought under pressure to overspeed his engine at take-off, which he will resist for obvious reasons.

For certain long range aircraft where the restriction on take-off run is not so great as for short and medium range aircraft, the excess power available at take-off may lead to engines which are virtually throttled at take-off. In fact, as the power of existing propeller turbines is increased there will be a general tendency for this to happen when increased cruising speed is the important requirement.

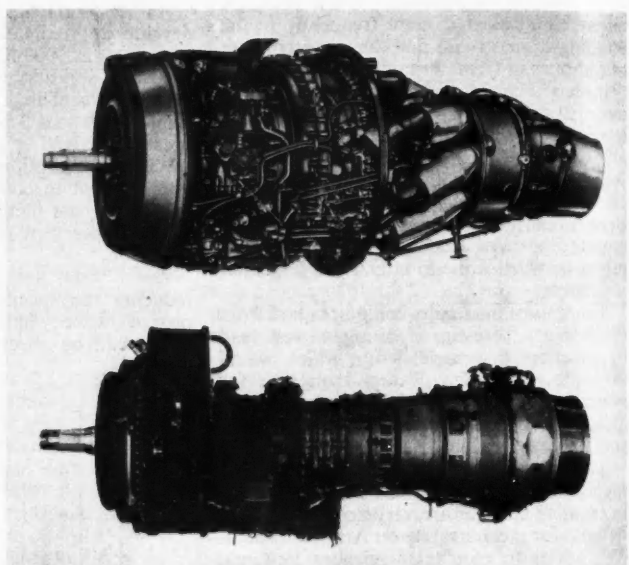


Fig. 3—The "Dart" and the "R.B.109" to the same scale

These considerations apply essentially, of course, to four-engined aircraft. For twin-engined aircraft the excess power available is usually welcome in order to meet the single engine case for take-off and climb and to enable the aircraft to use shorter runways.

Turbo-Prop versus Turbo-Jet

Much has been written on this subject but most of the technical considerations can be invalidated from the operator's point of view by the free choice of the man who comes along with his own money to buy a ticket.

We have already seen the public in America show a definite preference for speed at the expense of noise in the newer and faster piston-engined transports. We have also seen the public show its preference for comfort in the case of the "Viscount." I believe that the jet transport will have a great

passenger appeal over the turbo-prop transport on both counts, and that we shall increasingly see the jet transport, when it is re-established, invade the propeller turbine field, certainly for first-class travel, always provided that the airport noise of jet transports can be brought down to a level which is acceptable to the public.

In this direction some real progress has been made with final nozzle shapes which reduce noise, as outlined in Mr. Greatrex's paper at the recent Society of Aeronautical Engineers and Royal Aeronautical Society Joint Meeting in Los Angeles.† In addition, one of the main advantages of the by-pass type of engine may turn out to be its fundamentally lower noise level than the straight jet, amounting, according to our tests, to 8 decibels at the same thrust.

Apart from noise considerations, the limit of the invasion of the turbo-prop field will clearly be determined by the overall economies, taking into account the effect on load factor of passenger appeal, as well as the seat-mile cost. With this in mind it seems unlikely that the straight jet aircraft will come into the short range picture within the foreseeable future, but it is probable that there will be some invasion of the medium range field. In the long range field the turbo-prop will have to fight hard to retain its place and may only do so if it can provide very much cheaper seat-mile costs and thus effectively remove itself out of competition with the straight jet.

The Future

I think it has now been established beyond any reasonable doubt that the future of air transport lies with the gas turbine. As far as I am aware no new airline aircraft are under consideration or are being planned with piston engines, except in the smallest sizes. If this is so, then let us look at what sort of engines are going to be available to aircraft constructors.

Propeller Turbines Within the Next Five Years.—The next five years will undoubtedly see the emergence of the high compression ratio, two-shaft propeller turbine, which, with its improved fuel consumption, will tend to make existing single-shaft engines obsolete.

The rival virtues of high and low compression ratio are much the same in propeller turbines as in reciprocating engines. Heavy road vehicles have gone over to the high compression ratio diesel engine in the interests of fuel economy, but the medium sizes are slow to change and the smallest have not changed. Civil aircraft will probably use high compression ratio in only the larger sizes for the same reasons, which are that well-established and low-cost small engines exist, that the emphasis on fuel consumption is not so great over the shorter distances over which the smaller engine will be used, and that first cost is normally more important in the application of the smaller engine. Just as the petrol engine has progressively increased its compression ratio to narrow the gap between it and the diesel engine in the smaller sizes, so the single-shaft propeller turbine will undoubtedly continue to improve its efficiency.

If I might venture, as an engine man, to suggest the sort of use aircraft designers will make of the turbo-prop engines which are likely to become available during the next five years, it will be, first of all, safe to predict that they will welcome increased powers from existing engines as they always have done. Aircraft speeds will increase and new aircraft will be designed to start off with a significant speed margin over the types they are designed to replace. This period should see the introduction of medium and long-range turbo-prop aircraft and the introduction of twin-engined turbo-prop aircraft, of which a typical example will be Holland's Fokker "Friendship" (Fig. 4).

I believe that the turbo-prop is particularly suitable for fast twin-engined aircraft because of the low power plant weight, coupled with the relatively high powers which will be available for take-off and climb. These technical features, coupled with the increased reliability, particularly in terms of the reduced need to feather in flight, which I am certain will become established for turbine engines during this period, may lead to a revival in popularity of the twin-engined aircraft where cost of operation is paramount. It is even possible that turbo-props may result in the development of what has almost become a legendary aeroplane, the "DC-3" replacement.

If helicopters are going to play any significant part in air transport, then there is little doubt that the gas turbine engine will be the power plant. If such civil transports can be developed from military machines then it is possible that they would use the special engines which the military might have thought fit to develop for them. If, on the other hand, the civil requirements depart from the military, then it is likely that the engines used will be adaptations of existing civil turbo-prop engines.

Jet Engines in the Next Five Years.—Numbers of jet engines which are presently under development for military purposes should be available for civil use during the next five years, and the civil aircraft designer should have a considerably wider choice than he has with propeller turbines. But he will be restricted by the actual engines which are available in the particular size he requires and at the particular time he needs them, rather than by theoretical considerations of the ideal size and type. In other words, whereas on the propeller turbine side new engines are being developed specifically to suit a particular type and size of civil aircraft, on the jet side the civil aircraft man will have to take what is available. There is little possibility during the period under review of a brand new jet engine specifically designed for civil operation coming into service.

It seems that civil engine requirements of the larger aircraft during this period can be met by a number of straight jet engines presently in an advanced stage of development or in production in the 10,000 lb to 15,000 lb thrust class. As the makers of the only large by-pass engine in the world, the "Conway," we believe that this engine will find its place in those aircraft which are of a size to require an engine of the "Conway's" thrust.

As far as aircraft are concerned, this period should see the introduction into service of both medium and long-range jet transports.

The Long-Term Picture.—The path ahead for the propeller turbine is, from a technical point of view, the straightforward one of improving the overall efficiency by increased efficiency of components and development to permit higher flame temperatures, together with a continuing reduction in specific weight by getting more power out of the same size of engine.

How far down the scale of size the two-shaft axial engine can profitably be carried is a debatable point which will have to be resolved.

Far more important from the engine manufacturers' point of view is the point that has been touched on earlier—where will the jet engine take over from the turbo-prop? As mentioned previously, my own feeling is that by force of public preference the jet engine will invade the turbo-prop field.

On the jet engine side there is no sign of a slackening in military demands for more power at higher speeds, and the pace is likely to be governed by the pace of military developments.

Supersonic flight has arrived and I see no reason why supersonic transport will not one day follow.

The problems are enormous, but that is only a good reason for getting started on them. I can assure the aircraft manufacturers and the operators that when they are ready for supersonic civil transports the engine industry will certainly be ready with suitable engines, both to propel them and, if necessary, lift them off the ground.

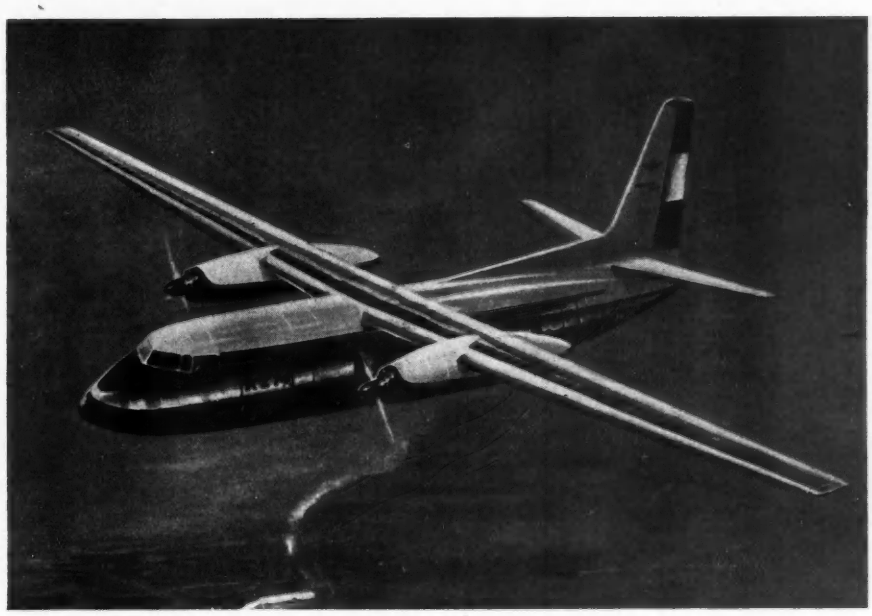


Fig. 4—The Fokker "Friendship"

† The Engineer, July 1, 8, 15, 1955

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"SIMPLICATE"

SIR,—I notice that in your editorial this week you help to perpetuate the attribution to Stout of the classic "simplicate and add more lightness."

In his book, *So Away I Went* at page 135, he says: "Gordon Hooton summed it up at a conference one day. He said: 'I get it. You mean simplicate and add more lightness.' That became a slogan around our drafting room, a slogan to be heard of later from another source."

F. H. SMITH

Royal Aeronautical Society,
London,
September 9th.

Literature

Diesel Engine Principles and Practice. Edited by C. C. POUNDER. London: George Newnes, Ltd., Southampton Street, W.C.2. Price 84s.

WRITING in the preface to this book, Mr. Pounder remarks that "Engineers and other technologists are often criticised for their indifferent powers of literary expression. But the engineer, or the chemist, or the physicist, is necessarily occupied with the matter of his subject rather than with its literary form and presentation." This is indeed very true, though we would say that the authentic test of the quality of any piece of technical literature lies in its ability both to interest and illumine the reader. Only in this way can it become—to use Mr. Pounder's word—a useful "tool." Most tools tend, in time, to become obsolete and should—the words are again Mr. Pounder's—"be discarded for a newer tool, i.e. for a later edition or a newer book. Many engineers' bookshelves would do more credit to a museum of antique first editions than to an up-to-the-minute engineering establishment." While we confess to a keen relish for any technical incunabula upon which we can lay our hands, the truth is that every day sees technical progress, though the rate at which such progress is translated into concrete production is governed by considerations practical and economical.

In the case of a book about diesel engines, wherein there are 848 pages, 580 diagrams and 112 tables, it cannot be supposed that between the date of completion of the text and the date of publication technical imagination has been at a standstill. Engineering science expands, indeed, at an ever-quickening rate and what may be the heterodoxy of to-day can become the orthodoxy of to-morrow. We are, moreover, at a period in technological history when vast changes are looming over the horizon and this causes us to look—as Kettering puts it—for the books which tell us what is likely to happen to-morrow. Meanwhile, we must have "tools" and the impressive compilation now before us (each of the twenty-six chapters has been written by an author or authors having special knowledge of the subject treated) certainly combines "the characteristics of a reference book with those of a text book." Commencing with a section on the "Theory of Compression-ignition Engines," we are taken through "Fuel and Combustion," "Fuel Injection Systems," "Scavenge and Exhaust Systems," "Theory of Exhaust Gas Turbo-Charging," "Exhaust-driven Turbo-chargers," "Heat Exchangers," "Lubricating Oils," "Starting Gear," "Transmission Systems," "Governors and Governor Gear," "Torsional Vibration in Shafting," "Balancing of Engines," "Metals Used in Diesel Engines," "Bearings and Bearing Metals," "Crankcase Explosions: Causes and Prevention," "Vehicle and Tractor Engines," "Engines for Rail-cars and Locomotives," "Air-cooled Diesel Engines," "Stationary High-speed Engines," "Engines of Moderate Power and Speed," "Dual Fuel Engines," "Marine Engines," "Vibration and Noise," "The Testing of Diesel Engines," and "Diesel Engine Maintenance." To cover such a range in a book of handy size is an achievement rendered the more notable by reason of the quality and authority of much of the matter thus provided. We can imagine the delight with which it would be received by some engine-minded Robinson Crusoe who found it thrown up on his Pacific sea shore. Mr. Pounder mentions that "the peak of the crescendo is reached with the marine engine," and this section extends, indeed, to eighty pages, the author being Mr. Pounder himself. Had publication been a little later it might have been possible to include a digest of the series of ten papers on marine applications which were submitted recently before the Congrès International des Moteurs à Combustion Interne. These papers may, however, provide additional matter for a later edition.

Readers of "Diesel Engine Principles and Practice" will find much to interest and inform them in all its chapters and while we recall having already read some of the contents, the primary object has been to provide a comprehensive reference book, and this can only be accomplished by including the relevant information. It is desirable, for example, that in a work descriptive of every category of oil engines an authoritative account should be given of crankcase explosions. We suggest, however, that in a book containing forty-two pages on crankcase explosions, the very important subject of "Bearings and Bearing Metals" is, perhaps, entitled to more than twelve. In this connection engine users look, among many other things, for guidance as to the respective merits of various casting methods. To the subject of engine maintenance, always of importance and never more so than at the present time, twenty-eight pages are allotted. This topic covers, of course, matters on which opinions may differ, but no one is likely to read the chapter without learning something from it. We would suggest, apropos the question of maintenance, that those who deal with engines on which severe accidents have occurred should tackle them much as a coroner tackles an inquest, i.e. no pains ought to be spared in ascertaining and making known the cause of death. By this procedure a great deal of subsequent misfortune may be avoided. Not enough is known as to the average duration of life of diesel engines in the various categories and there can be no doubt that in this connection, quality of maintenance exerts a major influence. If one engine can give a dependable life of, say, 120,000 hours, why is it that another engine of similar kind operating on comparable service, is discarded after about half this life? We fully agree with the references made to the importance of engine-builders' instruction books, regarding which we would quote the following bullion sense from a recent American technical publication: "Instruction books need not be fancy exhibits of artistic imagination or typographical achievement. But the well-designed book reflects the standards of quality inherent in your products. Written in sympathy with the man who will use it, the books should contain adequate information in an easily understood, well-organised form.... Tell your reader all that he should know without weighing him down with unnecessary theory of operation. But give him the fundamentals needed to efficiently operate and maintain the equipment." This has certainly been among the major objects of those responsible for the contents of the book which, edited and extensively contributed to by Mr. Pounder, is now available as "a serviceable tool to men whose onerous occupation it is to harness some of the great forces in nature for the manifold purposes of mankind."

An Introduction to Process Control System Design. By A. J. YOUNG. London: Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, W.1. Price 42s.

THIS book has a somewhat special and pleasing background. The author has been for the last seven years head of the Central Instrument Laboratory of Imperial Chemical Industries Ltd. The team which composes this laboratory has investigated, over a period of many years, both process control systems and the factors which influence their design. This work included their important contribution to the study of the frequency response of plant. Although they did not originate this idea for the assessment of plant performance, they certainly are the only people to investigate and develop it on a large scale. In addition to this work they have carried out very thorough evaluation of all types of automatic process control instruments from most countries in the world. Young's book is an essential and most praiseworthy effort to put this very large amount of work, by his section, into book form so that all those concerned with automatic process control may benefit from it. The book is aimed at helping both students who are studying this comparatively new art of automatic process control, and plant and instrument engineers who are concerned with this work. There is, therefore, sufficient mathematics in the book to permit a detailed study of the subject, but not too much to frighten away the engineer in industry. In addition to the mathematics there is an adequate supply of diagrams and graphs to help with the reading of the book.

The early chapters of the book give a very useful and logical approach to the principles governing the understanding of control systems. These chapters will prove very useful to plant designers, particularly since they show quite clearly the influence the characteristics of a plant can have on the performance of control systems. This section then leads quite naturally into the frequency response technique for studying plant reaction to sinusoidal input signals over a range of frequencies. This technique is described first of all theoretically and then one possible experimental approach is given. This particular experimental approach has been tried out on a large number of actual process plants by I.C.I. investigation teams. There follows a section on the characteristics of theoretical controllers and the prediction

of their settings on plants by the use of the frequency response technique. The basic principles of pneumatic controllers are then given, followed by a very comprehensive description of most types of controllers now available. This description not only includes all the latest pneumatic types, but it also describes various less known electronic, electro-pneumatic, and hydraulic equipments. Mr. Young then gives a very clear description of various lags which can occur at the measuring elements and also of those which often follow the actual measurement if pneumatic transmission is employed.

The last few chapters of the book concern themselves with some of the ancillary subjects of process control. There is a study by frequency response technique of transfer stages in plant. Useful chapters then follow on process control valve characteristics and the effect of disturbances on plant, together with some notes on the design of complex control systems. The very last chapter in the book summarises the principles discussed in earlier chapters and describes a procedure based on these principles for designing a process control system.

There are several appendices at the end of the book which include useful notes on process control terminology, adjustment of controllers, the automatic factory, and a bibliography of practically all published work on the subject of process control.

Electric Melting and Smelting Practice. By A. G. E. Robiette. London: Charles Griffin and Co., Ltd., 42, Drury Lane, W.C.2. Price 50s.

At a time when the quality of combustible fuels is deteriorating and their cost is rising, electric processes for melting and smelting metals assume an added attraction for the production not only of the complex alloyed constructional materials that modern engineering developments are demanding but also for the more common or bulk products and their ingredients. The almost certain economic feasibility of atomic power for peaceful purposes will lead to more readily available electricity, and we must look forward to using this form of energy and being able to reserve a larger proportion of our carbonaceous fuels as raw materials for the manufacture of the multitude of carbon-containing products needed to sustain and improve standards of living. It is, therefore, appropriate that a book should now appear surveying the whole field of the use of electricity for the thermal production of metals. Mr. Robiette, who has wide knowledge and experience of the design and use of electric furnaces, has extended and brought up to date his *Electric Melting Practice*, which appeared in 1953, so that his new book represents a valuable source of information about all electrothermal methods for the winning and refining of metals. Because the author has covered such a wide field, it has not been possible to deal in full detail with every aspect, but a very extensive bibliography at the end of the book gives the reader literature references enabling him to study further any particular portion of the field. The plan of the book is to describe in a general way the equipment and working methods that have been developed and found suitable for various applications, and then to consider in more detail the processes used for specific purposes, with reference to working and maintenance procedures, and purity, quality and overall cost of product.

After an introduction, the second and by far the longest chapter is devoted to arc furnaces for steel-making, though the aim of the chapter is broader than this, for the design and action of all direct arc furnaces are covered. The general construction and mechanical design of this kind of furnace are dealt with first, followed by some consideration of power supply and consumption, indicating the most economic way to release the maximum energy within the furnace. Since the length of time that a furnace is off power for charging has a great influence on overall power consumption the author is justified in giving much space to the question of expeditious charging. The electrical equipment for the supply and control of power to the furnace and the overall efficiency and energy balance are discussed at some length: the author then introduces a short section on electromagnetic stirring, an auxiliary that is the subject of much serious consideration at the present time, for by its aid more uniform materials may be produced in shorter times and with the avoidance of much unpleasant manual labour.

An important section is devoted to electrodes and to their selection and proper maintenance. Manual regulation of electrode position to vary arc length and so control energy to the furnace is no longer feasible and automatic methods must be employed. The essential characteristics of such regulation and the methods whereby arc current and voltage are used to actuate the electrode-carrying arms are indicated. The description of the furnace and its equipment is completed by a discussion of the types of refractory linings found suitable for steel-making and of the methods by which they are installed. The rest of this chapter is then confined to steel-making and the actual operation of arc furnaces for melting and refining under acid and basic conditions. The author surveys the relative economics of the open-hearth and electric processes for the production of bulk steel from cold charges, and shows the conditions under which the arc furnace would be the cheaper producer. The use of gaseous oxygen for carbon elimination, particularly from stainless steel, receives full and well-warranted treatment. The chapter closes with a brief review of the chemistry of electric steel-making. It is to be regretted that the author makes no reference to any modern work on this subject and that his misunderstanding of chemical thermodynamics leads him to erroneous statements. His attempts to describe the limits of deoxidation by carbon will confuse anyone not already aware of the significance of the carbon/oxygen/carbon-monoxide equilibrium, and the suggestion that the desulphurising action of fluorspar involves the evolution of fluorine gas will surprise many a chemist. When so much has been carried out and published on the subject of steel-making chemistry, it is strange that the author should be content with what he has written.

The third chapter concerns arc furnaces, both direct and indirect, for use in the iron foundry. The author gives an unbiased assessment of the place of the cupola in the foundry and recommends the arc furnace only where the composition of the iron and the casting to be made render it essential. There is a very comprehensive account of the rocking direct arc furnace, of its mode of action, and of the advantages to be gained, both in heat transfer and reduced refractory consumption, by rocking the furnace body about the horizontal electrodes. The direct arc furnace is more applicable to larger charges and for serving as a holding vessel and this aspect is well treated. The function of the arc furnace as a duplexing unit, that is a vessel in which cupola-melted iron can be superheated, refined or changed in composition by the addition of steel scrap or alloys, is described in a convincing way.

A short chapter on arc furnaces for the melting of non-ferrous metals deals particularly with the melting of copper and nickel and their alloys in direct and indirect furnaces. The author then deals in two longish chapters with induction furnaces, i.e. normal frequency (channel) and high frequency (coreless) types. The various designs are very fully described and the installation and working methods should be of great interest to a wide range of technicians. In these, as in other chapters, details are given of actual production runs from which realistic assessments of the worth of these furnaces can be made. Another useful chapter deals with resistor furnaces. These are essentially simpler in construction but of more limited applicability. Nevertheless, for certain tasks they are of undoubted value and the place they occupy in the metal industry is well-illustrated by examples given. The last three chapters of the book deal with smelting, i.e. the winning of metals or alloys from their ores. While the greatest bulk of iron is still made in the blast furnace, the increasing availability of electric power and the increasing shortage and deteriorating quality of coking coals have made the production of iron by electric means an economic proposition in many parts of the world. Mr. Robiette has had direct personal experience of the design of electric smelting plant and gives a masterly account of its development, the furnaces employed and the results to be obtained, as regards both quality and economics. The same can be said of ferro-alloy production and in the chapter dealing with this the author describes in a competent way the manufacture of a number of important alloys. The final chapter gives a brief survey of the production of copper and nickel mattes and of nickel, tin, lead and zinc smelting.

To sum up, Mr. Robiette's book is a commendable survey of an increasingly important branch of technology, in which both practical and economic aspects are given due weight. It is irritating to find in such a valuable book that there has been some lack of care in its preparation at various stages. Thus, the contents list shows two chapters with titles differing from those which head the actual chapters, there are many missing decimal points, a number of missing figures in a table, a few misprints and a strange spelling of the now well-known Austrian town of Donawitz. In discussing the use of oxygen, the author stresses that this makes it possible to remove carbon without undue loss of chromium and yet goes on to say that most of the chromium is oxidised and can be recovered from the slag. The reader will find it hard to believe the explanation given on page 326 for the chromium content of a steel made by smelting a Cuban laterite. While the book is profusely illustrated in both line and half-tone, some of the latter illustrations are so badly reproduced as to conceal the very features they are intended to show.

Books Received

Diesel Maintenance. Fourth edition. By T. H. Parkinson, edited by D. W. Smith. London: Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 12s. 6d.

Electrical Measurements and Measuring Instruments. Fourth edition. By E. W. Golding. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 40s.

Principles and Practice of Electrical Engineering. Seventh edition. Revised by G. A. Wallace. London: McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 56s. 6d.

S.B.A.C. Flying Display and Exhibition

No. II—(*Concluded from page 374, September 9th*)

Engines

THREE engines flew in public for the first time at Farnborough, the Bristol "Orpheus" in the Folland "Gnat," the Rolls-Royce "Conway" under the Avro "Ashton," both these being seen in Fig. 15, and the de Havilland "Gyron" in a Short "Sperrin."

The Bristol "Orpheus" is a lightweight engine in which simplicity has been striven for, principally to meet the needs of light fighters. Its initial type test at 3285 lb thrust was completed in May this year, and this rating gives a thrust/weight ratio of 4·4 : 1 at sea level. The engine, which we illustrate in Fig. 10, is a single-shaft axial design with seven separate flame tubes inside an annular combustion chamber. It is barely 6ft long from intake face to exhaust flange, and only 32·4in in diameter. The few accessories are mounted below the compressor to reduce the need for access panels. It is stated that materials and construction are alike classical, resulting in economic production and rapid development.

The Rolls-Royce "Conway" also impresses by its compactness; it was shown on the same stand as a 10,000 lb thrust "Avon," and appears to be no larger in diameter. As illustrated by Fig. 11, it has a vast air intake and the long inlet guides are, naturally, shrouded. The internal arrangement was described on page 345, September 2nd last; it was noticeable that the by-pass air leaves through a very narrow annulus downstream of the turbine. On the port side an auxiliary gearbox, presumably geared to the front of the high-pressure compressor, is coupled to a large dynamotor. The ten spill burners are interconnected by straight rigid pipes with threaded connectors; the restricted access to sprayers and combustion chambers on a by-pass engine is considered by the makers unimportant, as no attention is required by them during the overhaul life. The "Conway R.Co.5" is type tested at 13,000 lb thrust.

The de Havilland "Gyron" is by any standard a big engine. Roughly 13ft long and 4ft in diameter, it offers 15,000 lb thrust in sea level static conditions. However, it is intended to power aircraft flying at supersonic speeds and therefore takes advantage of the ram compression ratio, which may be 3·5 to 4 at Mach number 1·5. Thus the engine has relatively few stages of compression and expansion, and is claimed to be comparatively light in weight. Fig. 14 shows that the exterior of the engine is simple and there is a suggestion of a two-stage turbine. Seventeen burners are fitted to a combustion chamber which appears to widen downstream; little else can be said of the engine, but it is started by a mono-fuel turbine in the intake bullet. In the Short "Sperrin" used as a flying test bed, the "Gyron" appears to need a nacelle of about twice the cross-sectional area of the "Avon" replaced; it was announced recently that a smaller version, the "Gyron Junior," was in existence.

The Napier "E.151 Eland" is intended for the twin-engined Fairey "Rotodyne." In this aircraft the rotor is driven by jets at the tips of the rotor blades, and the engines supply combustion air to the rotor under pressure. The "Rotodyne" normally flies autorotatively, and only at take-off and for hovering are the tip jets ignited; consequently the auxiliary compressors need to be disconnected for the major part of the flight, when all the power goes to the airscrews. This is done by means of a fluid coupling on the downstream end of the turbine shaft, the exhaust duct dividing and discharging at the sides. The auxiliary compressor has nine stages for a pressure ratio of over 4 : 1. The airscrew, as in a normal "Eland," is driven by straight-toothed gears from the front of the compressor, and since it must be brought to extreme fine pitch for helicopter flight it is also made to provide braking. The engine is illustrated in Fig. 13.

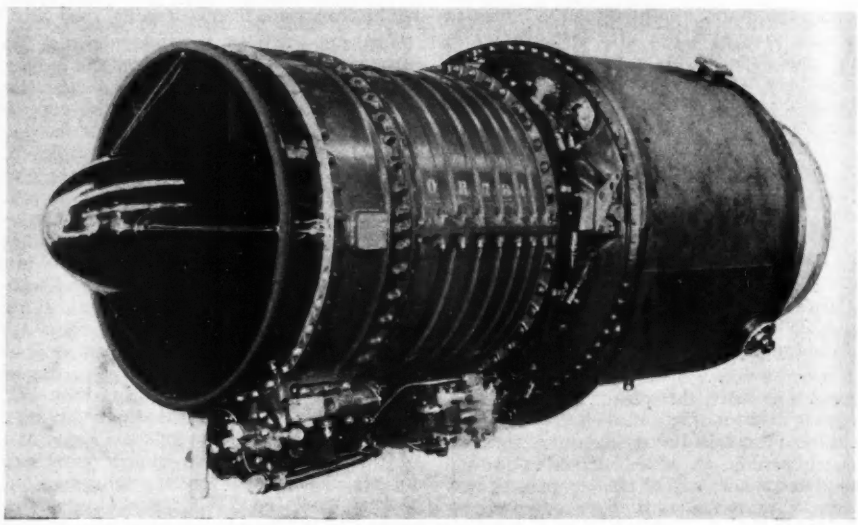


Fig. 10—The "Orpheus" has its starter motor inside the intake bullet, driving the rotor direct; it appears to be a turbine exhausting through the hollow radial vanes

Equipment and Accessories

The static exhibition covered, besides engines, a vast variety of products ranging from exceedingly refined aircraft accessories to simplified equipment for expendable targets. A neat and adaptable indicator, with three displays corresponding to either or neither of two electric circuits energised, was shown by Dowty Equipment, Ltd., Cheltenham. The four panels visible in Fig. 16 each consist of one side of an equilateral prism, and a rack-and-pinion energised by solenoids moves the four together to the three possible positions. Each display has no surface in common with the others, and the designer can choose any letter, symbol or colour for each. The normal running voltage is 28 to 30 d.c., consuming 0·067A, and it weighs but 2·2 oz.

The problem of presenting information to the pilot is also studied by Thorn Electrical Industries, Ltd., 105–109, Judd Street, W.C.1, who showed the "Plasteck" system of instrument panel illumination. The light sources are minute filament bulbs which are set within the thickness of an acrylic plastic sheet, cut out in way of dials and switches at such an angle that the light is directed upon them. The faces of this sheet carry thin layers of translucent white plastic, and bonded on to the outer face is an enduringly matt opaque black skin. All inscriptions are cut through this black sheet, and thus the white plastic below shows in reflected light during the day and transmitted light

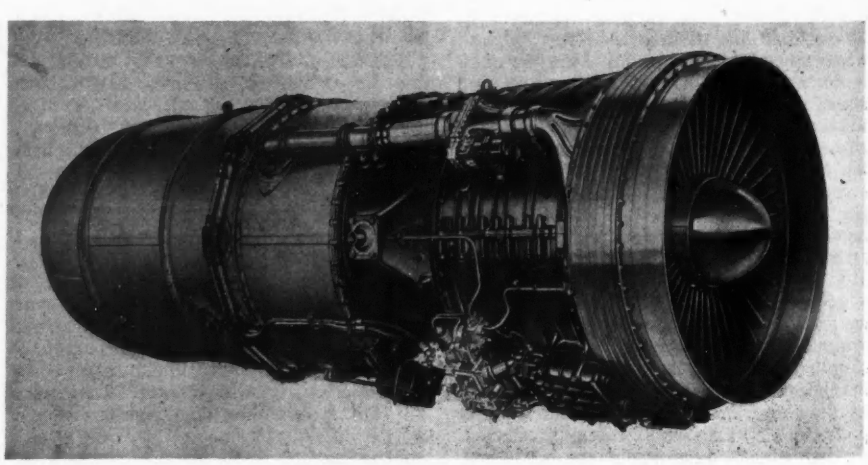


Fig. 11—The "Conway" by-pass engine, showing the hot air duct for de-icing the inlet guide vanes and the rigid pipes connecting the ten sprayers

during the night. Red filters surround each panel lamp, so that the pilot's adaptation to darkness is not disturbed by referring to the panel.

Another occasion on which the pilot cannot refer readily to his instruments is the approach to an aircraft carrier, when his vision is concentrated on guidance from the deck. Kelvin and Hughes, Ltd., of Basingstoke, showed an audio approach system which gives air speed indication through the pilot's headphones, without blocking speech traffic. In the speed-sensing unit a Pitot-static bellows controls an electric motor which strives always to drive the spring loading the bellows to a compression corresponding to the desired approach speed. It hunts continuously when in use, and the point about which it fluctuates depends on the bellows force, i.e. the indicated air speed ; a commutator on the motor shaft feeds rhythmic signals to the pilot at the basic frequency of the hunt. An accuracy of ¼ knot at 110 knots is claimed to result from the very small range of deflection of the bellows.

On an adjacent stand was shown the Smith's flight system, specified for future B.E.A. " Viscounts " and " Britannias " of B.O.A.C. and El Al Israel Airline, differing at first sight from the standard blind flying panel in that the artificial horizon is replaced by a director horizon and the gyro compass by a beam compass. These, in addition to the ability of the earlier instruments to refer to space axes, can also present the position and course of the aircraft relative to a v.h.f. omni-directional range beacon or an instrument landing system beam. This information is not only available to the pilot, but also to the " S.E.P.2 " automatic pilot, and the automatic pilot can, therefore, either fly on a preselected course or make an approach along a glide path to a runway. The " S.E.P.2 " employs magnetic amplifiers in place of thermionic valves and is able to monitor speed and altitude : it is capable of pressure pattern flying. The automatic pilot can make changes of heading to fresh courses, and there are controls to allow the pilot to manœuvre while it is engaged. The system is designed for dual control aircraft, and the two panels draw their signals from common radio, gyro, and magnetic instruments with a high degree of duplication and failure warning ; a simple magnetic compass appears as a standby. We are advised that the displayed instructions prove satisfactorily instinctive, and that pilot-flown instrument approaches are greatly facilitated.

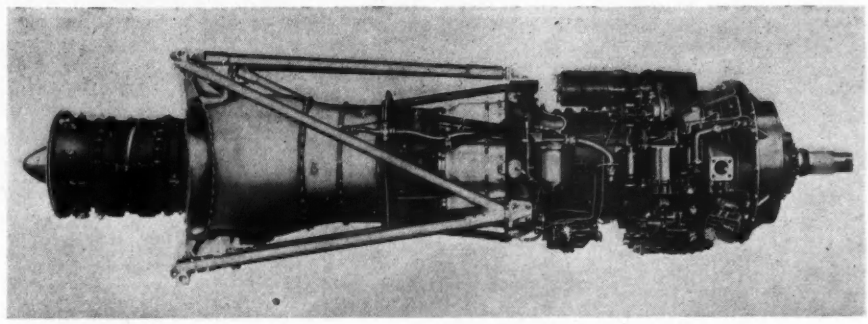


Fig. 13—Behind the engine mounting of the " Eland " N.El.3 is the auxiliary compressor, driven by a fluid clutch between the bifurcated exhaust ducts

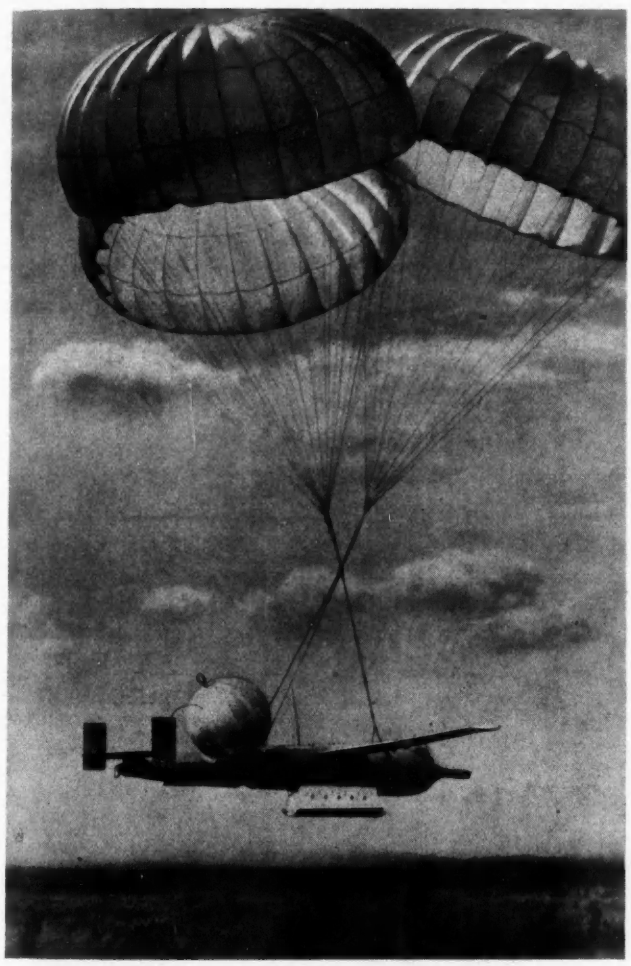


Fig. 12—The " ML " guided aircraft parachutes to earth with flotation bag and landing cushion inflated

An aircraft which is controlled at all times by its automatic pilot is illustrated in Fig. 12, the " M.L." radio-controlled guided aircraft, designed for ground-to-air gunnery practice, radar plotting and similar exercises. Of 14 ft span, it is designed to fly at 200 knots on the 65 h.p. at 5000 r.p.m. output of a Vincent " Picador " 998 c.c. engine driving through a right-angle drive in place of the gearbox ; the engine is, unusually, mounted with the exhaust ports at the rear of the cylinder heads, and has timed fuel injection into the induction pipes downstream of the throttles. With a twin-cylinder engine the two-bladed propeller can be fitted to stop consistently in the horizontal attitude, and thus is not damaged when the aircraft lands under a parachute ; it is not hand swung, but started electrically by a dog on the crankshaft. The parachute is expelled from the aircraft by the inflation of a flotation bag, either under radio command or in any emergency condition, and in its turn causes the shock absorber air bag under the centre fuselage to inflate. The airframe is conventional except that rudders are not provided ; the aileron actuator control gyroscope is mounted at 45 deg. to detect roll and yaw disturbances. Pitch control is by a barometric rate-of-climb detector. Radio control offers ten command channels, seven of which are used to fly and " land " the aircraft itself. The machine is launched in zero length from an easel by two standard 3in rocket motors, whose carrier falls away at all burnt.

In our issue of July 15th, page 75, we referred to the work done by the Royal Aircraft Establishment on kinetic heating of airframes. Philips Electrical, Ltd., showed a 1000W tubular infra-red lamp used in this research ; it is made from pure quartz tubing in order to transmit the maximum infra-red radiation and to allow its use in high temperature applications. The rated life of this lamp is 5000 hours, running on 220/230V.

The Precision Engineering Division of Short Brothers and Harland, Ltd., showed some new applications for magnetic ferrite that have sprung from the cost and difficulty of suppressing eddy current losses at even the existing aircraft standard frequency of 400 c/s; with even higher frequencies, e.g. up to 3000 c/s, coming into favour on more recent developments, the present-day methods of constructing laminated magnetic assemblies, such as stators and rotors, left a great deal to be desired.

Little research work seems to have been done on these materials until recently, when, during the second world war, extensive investigations in Holland resulted in a commercial ferrite under the trade name of " Ferroxcube."

Depending upon the oxides used and upon their subsequent treatment, ferrite behaves magnetically like soft iron or as a permanent magnet. Whilst the saturation flux density of ferrites is low, the materials have one very great advantage over metallic magnetic materials, namely, that of a very high specific resistance. From a practical point of view this results in an almost complete absence of eddy current losses.

Moulding the ferrite into the required shape before sintering is undoubtedly the most satisfactory method for quantity production, but one-off methods utilising ultrasonic drilling techniques have proved highly satisfactory. Both methods compare very favourably in simplicity and economy of operations with the laminated form of construction. The stator in the centre of the

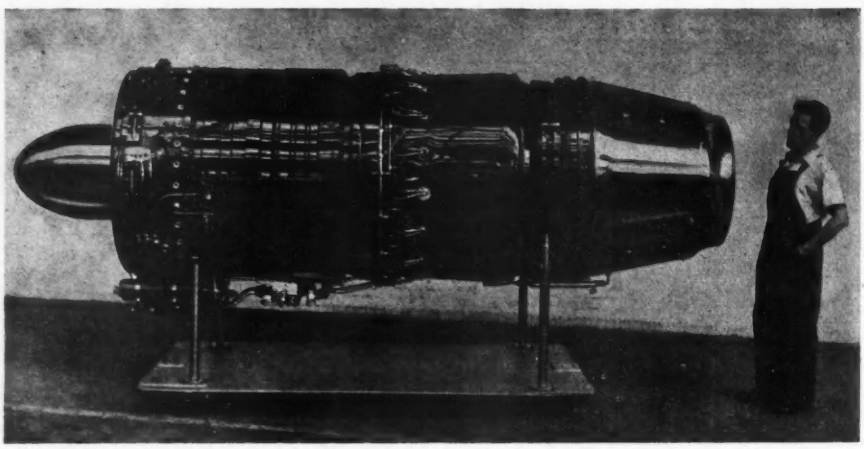


Fig. 14—The linkage directly above the front support of the "Gyron" appears to adjust the thirty-six inlet guide vanes

Most engineers are familiar with the bayonet-operated couplings in small sizes which are commonly employed on low pressure air systems, working at pressures up to about 80 lb per square inch..

The application of these devices to high pressure systems and in particular to systems employing hydraulic oils, fuels, &c., presents greater difficulties, not only on account of the higher pressures but also due to the necessity of avoiding even slight seepage during the process of connection or disconnection. In addition there is an essential requirement that a coupling of this type must not introduce air into the pipeline.

A coupling meeting these requirements was exhibited by the Automotive Products Company, Ltd., and it is standardised in a range of sizes. It consists of complementary halves, each embodying sealing valves which are opened during the process of connection and closed when the coupling is separated. Both the valves are hermetically sealing, i.e. they have synthetic inserts which ensure absolute freedom from seepage when the coupling is disconnected.

In this coupling the interior parts are made entirely of stainless steel, including the springs. The outer portions are normally in

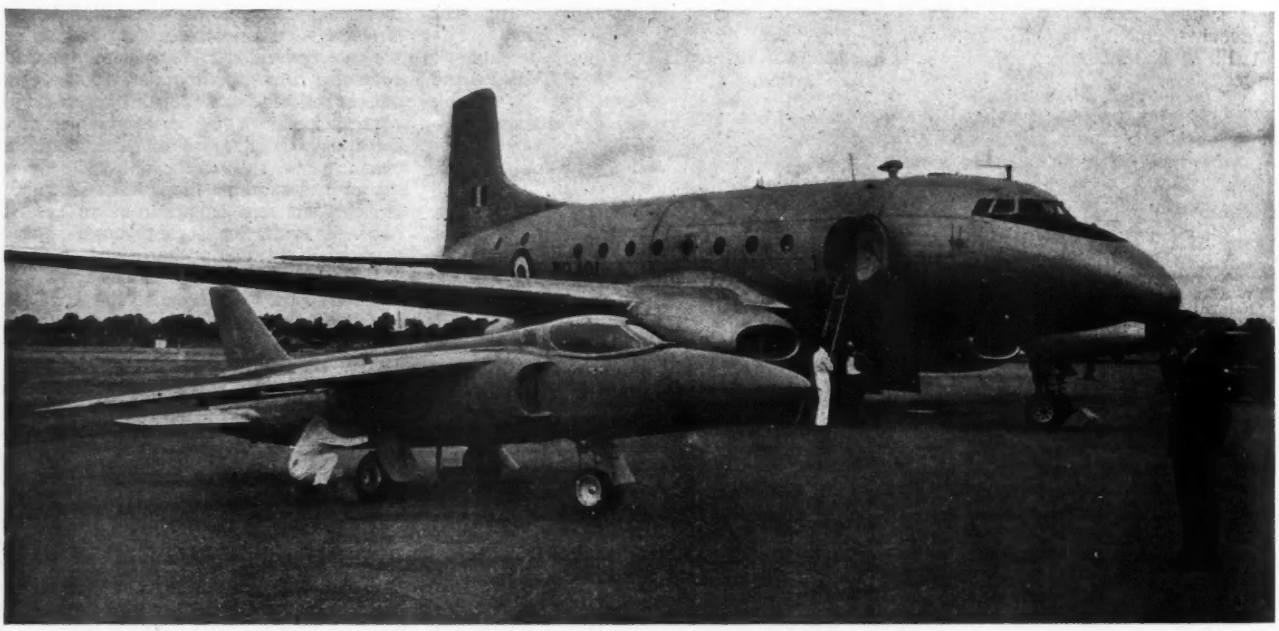


Fig. 15—The largest and the smallest jet aircraft flown at Farnborough last week: the Avro "Ashton" (span 120ft) and the Folland "Gnat" (22ft 2in). Noticeable are the small thick door of the pressurised flying laboratory and, on the fighter, the moving tail-plane and the hinged hood

illustration Fig. 17 was machined in one operation from the blank shown above it, using an ultrasonic drill.

Ferrites can be ground to very fine limits, thus placing no limitations on design of air gaps, an advantage when compared with laminated components. The rotor assemblies at the bottom right and left of the illustration show the finish that can be obtained when a large number of parallel slots are ground in a ferrite component.

The components to the right of Fig. 17 form a motor possessing a simple two-pole winding. Such a motor would have a synchronous speed of 150,000 r.p.m., but by selecting certain combinations of rotor and stator slots "crawling" is encouraged; the rotor locks into synchronism with a harmonic field and runs at approximately 7000 r.p.m. The effect is to achieve low speeds from a high-frequency supply, without using a gearbox at prohibitively high speeds, and while still retaining the very simple windings desirable in small machines.

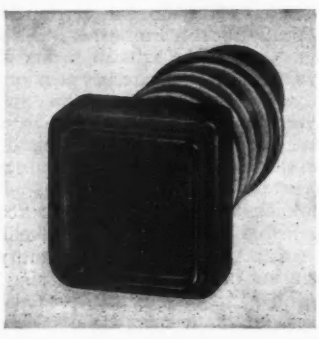


Fig. 16—This miniature indicator can present three different displays on its ¾in square face

Fig. 17—2400 C.P.S. motors, showing non-conducting magnetic ferrite components

light alloy and the coupling halves are held in connection by a light alloy swivelling union sleeve, the latter carrying stainless steel hardened pegs engaging corresponding slots in the fixed half coupling.

The coupling, as at present made, is suitable for working pressures up to 3000 lb per square inch and it is intended, in the near future, to increase this working pressure up to 4000 lb per square inch. The normal test routine includes a hydraulic test of one-and-a-half times the rated working pressure. The couplings have been employed on manually-operated braking systems in which the pipelines are disconnected when the vehicle is to be transported, and later reassembled for instant use without "bleeding." The couplings have also been used successfully with fuels, lubricating oil, water, air, oxygen, nitrogen, &c., and will be available in the very near future (with modified seals) for refrigerator systems employing ammonia, Freon 12, &c.

An interesting exploitation of both the light weight and high temperature properties of titanium alloys was displayed by William Jessop and Sons, Ltd., in the form of a gas turbine disc forged in "Hylite." The useful creep strength of these alloys is in the range 300 deg. to 400 deg. Cent., and this turbine disc is air cooled in service: compressor discs offer a wider field for these alloys.

The exhibition included a number of displays of honeycomb stabilised metal structures, and demonstrations of their stiffness in torsion and compression were featured.

Industrial Health Service

By R. J. SHERWOOD*

SINCE 1920 Slough, which lies about 20 miles to the west of London, has grown from a village to an important centre of light industry. This expansion has been due to the development by a private company of a large area of land as a trading estate, where manufacturing firms can rent buildings to carry on their processes. In consequence of the demand for labour for these industries there has been a rapid influx of workers, which has thrown a heavy burden on the local hospitals and other medical services. To alleviate this the Slough Industrial Health Service was founded in 1947, sponsored by the Nuffield Foundation, Slough Estates, Ltd., and a group of manufacturing firms, to provide medical care for the workers in local factories. From a small beginning the Service has grown until to-day it is supported by 168 firms, employing a total of over 17,000 workers, each firm contributing annually 16s. per employee towards the running costs.

An integral part of the Service is the Recuperative Centre at Farnham Park, where injured people, or those recovering from operations, are treated to ensure quick and, wherever possible, complete recovery. When full recovery of working ability is not possible special training is given in conjunction with the local Government Training Centre, so that, despite disability, an individual is still able to take up some suitable employment. Out of 647 persons treated last year, 340 were able to return immediately to their former employment, 134 went straight to other jobs, and 33 were retrained for other work. Cases are referred to the Centre from many parts of England, though patients from local hospitals have first priority.

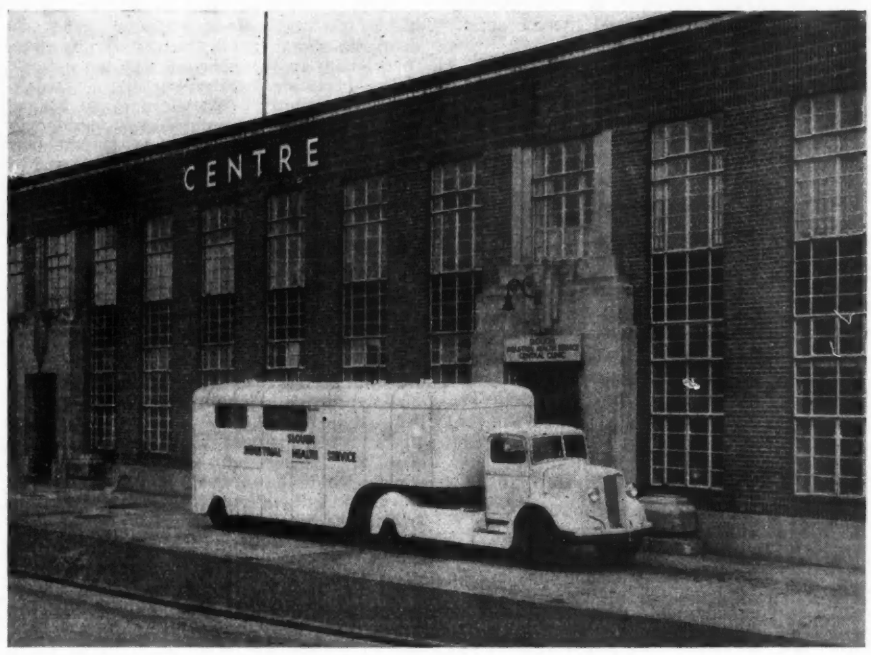
On the Slough Trading Estate the Service has a Central Clinic, two dressing stations and one mobile dressing station; in addition to which the Service uses facilities in several of the larger firms. Last year there were 33,540 attendances at the clinic and dressing stations from a population at risk of 9398. Of new cases requiring treatment, 40 per cent were from industrial causes. On a conservative estimate the number of man hours saved each week for this particular group is approximately 1000.

In addition to the first-aid and minor treatment facilities, there is an emergency casualty service. A doctor and nurse are always available during normal working hours to go immediately to the scene of a serious accident. Facilities for X-ray, physiotherapy and chiropody are also available at the Central Clinic, together with a social service which helps to deal with financial and domestic problems that arise in ill-health.

From its inception the Health Service has taken an active part in preventing occupational diseases and accidents, and to further this end an occupational hygiene team was formed in 1950.[1] This was established in conjunction with the London School of Hygiene and Tropical Medicine, where the needed laboratories were located. The team consists of a doctor, a chemist and a health engineer.[2, 3] During the four years that the team has been working in Slough it has submitted thirty-two reports on environmental conditions to member firms. Working as the Sub-Unit of Occupational Health of the London School of Hygiene and Tropical Medicine the team has investigated health risks in a number of factories elsewhere in the Greater London area, submitting seventeen reports.

To investigate a possible health risk arising from the use of a toxic material, members of the team first survey the suspected process. If any possibility of poisoning exists, a thorough investigation is undertaken. The doctor examines the workpeople to see if they show symptoms of poisoning and arranges for any special examinations to be carried out (i.e., chest X-rays or blood counts), while the chemist and the engineer take samples of the air for analysis, and urine specimens may also be collected. On return to the laboratory the air and urine samples are analysed and the results are compared with permitted safe limits. These "threshold limits" have been drawn up by various bodies, both in this country and in the United States, mostly as a result of industrial experience of toxic materials. When the investigation is completed a detailed report is sent to the firm concerned, in which the medical, chemical and engineering aspects are discussed, the measurements of air and urine concentrations are recorded, and, when necessary, detailed suggestions are made for controlling the hazard. Wherever any possible risk to health has been detected the managements of firms have invariably taken steps to improve the situation, usually along the lines suggested by the health engineer. Following improvements, further investigations are made to ensure that conditions have been made safe.

The team has investigated hazards arising from a considerable number of different materials, including asbestos, talc, lead, antimony, arsenic, nickel, fluon, benzol, trichloroethylene, carbon monoxide, chromic acid, and others.



Slough Industrial Health Service, central clinic

The following are presented as typical examples of the way the team works:—

(1) *A Benzol Hazard.*—Four men were engaged in a process involving the use of benzol. None of the men showed symptoms of disease but examination of blood samples showed that one man was in fact suffering from chronic benzene poisoning. This man was suspended from the work for two years and his blood picture has gradually returned to normal. As soon as the hazard was discovered, the concentrations of benzene in the air were determined and found to be

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unsafe. Following the installation of an exhaust system the concentrations in the general atmosphere fell to a low level, but brief exposures to high concentrations still occurred from time to time and analysis of the urine of the workers showed that some absorption of benzene was still occurring. It was then found that the process could be maintained with a mixture of benzene and petrol solvent ; this effectively reduced exposure to the hazardous benzene still further. Nevertheless, another man who had been working there for some years began to show irregularities in his blood so further investigations were made, including measurements of air concentrations and a series of urine analysis over a period of six months. Following these, it was found possible to eliminate the benzene completely from the process, using instead a mixture of petrol solvent, toluene, and methylethylketone. Although these materials are not nearly so toxic as benzene, a continued watch is being kept on the men and the process to ensure that no further trouble occurs. This study was made in close collaboration with the works chemist.

(2) *A Lead Hazard.*—Another problem arose in the cleaning of boilers fired with creosote pitch. It was necessary for men to enter the combustion space for this work and they were inevitably exposed to massive quantities of dust which was found to contain a small percentage of lead. Analysis of the urine of the men showed that, although approved respirators (Mk. IV) were being worn, lead absorption was occurring ; while the amounts were not immediately dangerous, this was considered bad practice and supplied air respirators are now provided. These are also popular with the men, as there is no resistance to breathing, and the air supply is pleasantly cool.

(3) *An Uncomfortable Office.*—Another and rather different example of the team's work is a thermal survey of an office block. The staff of a new building complained of stuffy conditions and the manager reported a great deal of sickness absenteeism. When the offices were surveyed and the staff questioned, it was found that the air was overheated and not moving sufficiently. To prevent overheating, thermostatic control of the pump which circulates hot water through the convectors was introduced. While the lack of air movement, which caused the sense of stuffiness, could be overcome by opening existing windows, this invariably led to cold draughts and heated argument. The windows are now being modified so that incoming cold air is directed towards the ceiling to mix with the warm air already there before descending to head level. If conditions are still found uncomfortable, the installation of air bricks behind the convectors is proposed.

These examples serve to show how the hygiene team applies scientific methods to improve working conditions. Many problems are also dealt with from day to day by simple remedies and do not require extensive investigation ; this being particularly true of the safety aspects of the work.

As will be seen from the examples quoted the hygiene team does not attempt to undertake fundamental research but rather applies existing knowledge to solving individual problems and ensuring healthy working conditions. The team's activities to date have shown not only that such work is possible, but also that there is a marked need for it even in a group of factories as modern as those at Slough.

As increasing attention is being given to the problem of providing health services for industry the Slough Industrial Health Service, with its occupational hygiene team, is of interest as offering one solution which can be applied where factories are grouped closely together. By this method small firms are able to share medical and hygiene facilities which otherwise would be beyond their means.

In conclusion I should like to pay tribute to fellow members of the hygiene team, P. J. R. Challen, physician, and Joan Bedford, chemist, and particularly to P. H. Nash, physician, formerly of the team.

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British Association Meeting at Bristol

No. II—(*Continued from page* 380, *September 9th*)

THE meeting of Section G, Engineering, on Monday morning, September 5th, began with two separate sessions. At one of these sessions, the papers presented for discussion were "Motorways." by Mr. J. A. Proudlove, and "Motor Vehicles and Design," by Mr. J. N. McHattie.

The latter paper described the task facing the automobile engineer in designing and producing cars, commercial vehicles and public service vehicles for various markets. The development of mechanised road transport was reviewed and trends traced so that some indication could be obtained of possible future developments.

Motorways

The special purpose roads which have been planned for this country were described by Mr. Proudlove in his paper, with some historical information about the various attempts made in the past to achieve the construction of a motor road system. After describing various recent ideas in road design which will find their places in the new motor roads, the author drew some comparisons from Continental motor roads.

In conclusion, he pointed out that much had been written since the war urging the immediate construction of special-purpose motor roads, both in the technical and the national Press. It had been made clear that no densely-populated country could afford to do without motorways and express routes, both on economic and humanitarian grounds. At present over 70 per cent of our goods tonnage was moved by road transport, and the figure was increasing, particularly for short hauls. It was only for bulk freight and long hauls that rail could compete economically with road transport. And that was with artificially high costs for road haulage caused by the high fuel tax, road tax and the use of vehicles which had to be designed to operate under unfavourable road and traffic conditions. Those conditions gave rise to time wastage costing many millions of pounds annually when taken over the trunk roads of the country, and the fuel consumption of vehicles could be reduced by 20 to 30 per cent if they were to be operated over motorways. It was now expected that the number of vehicles on our roads would double within the next decade. Daily life in towns and cities affected by trunk road paralysis had already become intolerable and was seriously threatening commerce, costing the communities affected incalculable millions in lost time. In those towns, too, accident rates were rising alarmingly, and if there were no economic reason for building motorways, there would still be sufficient justification for their construction from the great reduction in casualties which must result.

Most of the counties through which the proposed motorways would pass were actively preparing plans and some of the first parts of the North-South motorway which would be constructed would be in Lancashire, where the need for increased communications was extremely acute. The present main trunk route, A.6, from London to the north and Scotland, lay through the centre of industrial Lancashire. Of its 63 miles in the country, thirty had a speed restriction, there were over 500 intersections, twenty sets of traffic lights, four low bridges and three level crossings. In contrast, there would be about fifteen junctions all grade-separated in the 58½ miles of the North-South motorway in Lancashire. It was estimated that the effect of the motorway would be to reduce the journey time through the country from about 2½ hours at present to about 70 minutes, so saving perhaps £1,000,000 a year in time value alone. Four million people lived in Lancashire within 12 miles of the proposed motorway. They were depending upon it to open congested areas and to allow normal life to return to towns along the trunk routes, with a saving of perhaps 500 casualties a year.

The way ahead had been shown by Germany, France and America and was clearly that it was not worth while converting old roads to main highways. Future traffic needs must be met by constructing new motor roads, which were being built with all speed in almost every country as an economic necessity. Since we, in this country, had lost so much leeway in our road building we must now apply ourselves to making good our deficiencies, at the same time profiting from the experience of others. If built now a motorway would cost us about £250,000 a mile and the establishment at the earliest possible moment of a central motorway authority with powers to raise the £200 million required for the complete scheme would be a most laudable act of any government, for the scheme was essentially a whole and each motorway must of necessity be built complete as one undertaking.

During the course of the discussion of Mr. Proudlove's paper, Professor W. F. Cassie said that the problem was not a technical one ; it was an economic and political problem. It was important not to regard these motorways simply as roads—they were almost systems of life, and raised social problems. The German system was run by a body which controlled the roads, the restaurants, the filling stations and everything else concerned with them. Although the rest houses and filling stations were run by private operators, they could be dispossessed if they did not run them properly. The greatest care was taken over matters of appearance and amenities. When on the roads, drivers were, so to speak, cut off from the life of the rest of the country. If a car broke down, the driver could not walk to the nearest village, but if he walked to the nearest telephone at the side of the route—or asked some other driver who was passing to put through the message for him—on picking up the instrument there was an automatic connection with the nearest repair depot of the *Autobahn* control. At some points one might see a large blackboard at the side of the route saying that there was a telephone message at a certain filling station for a certain driver.

Particle Accelerators

The second session held under Section G of the meetings on Monday morning commenced with two papers reviewing machines for accelerating nuclear particles, namely, "The Linear Acceleration of Charged Particles to High Energies," by Mr. C. W. Miller, and "A Review of Accelerating Machines for Nuclear Particles," by Dr. J. B. Adams.

Dr. Adams pointed out in his paper that in introducing a subject which was specialised and remote from everyday life, it was usual to try to form some links with common experience which would help a non-specialist to appreciate the scope of the subject and the problems which it presented. Unfortunately, both the reasons for wanting to build high-energy particle accelerators and the problems encountered in trying to build them did not easily link with the engineering world. The machines themselves, of course, were perfectly easily understood examples of modern engineering technology, but the object

of his talk was not to give a mere catalogue of machines. It was much more interesting to see why they were needed and how they had been developed over the past twenty-five years.

There existed a common misunderstanding, he went on, that high-energy particle accelerators were directly connected with atomic energy and that their development was therefore helping to provide atomic energy power stations. It was true that the lower-energy accelerators did play some part in the atomic energy research programme, but the really high-energy machines had almost nothing to contribute to that programme. Those machines were built to further research that had no immediate practical application. Nobody could say how the results of this work would affect atomic energy or any other branch of applied science in the future, and, for the moment, the results only increased our knowledge of the fundamental particles that went to make up our universe.

The discovery by Becquerel and the Curies that some substances, notably radium, emitted some form of rays or particles was common knowledge. When such a naturally occurring phenomenon as that was discovered it was inevitable that someone would build a machine to do the same job a little better. Cockcroft and Walton, working with Rutherford at Cambridge, built such a machine, a high-voltage set, and accelerated particles to an energy comparable with the natural sources. That was one of the first particle accelerators used for nuclear experimental work and with it many major discoveries had been made concerning the internal composition of the nucleus of the atom. To proceed further with these researches, higher energy machines were soon demanded and those physicists with leanings towards engineering needed very little encouragement to start constructing bigger machines and to start thinking of new ways of accelerating particles.

Dr. Adams then went on to review particle acceleration, such as the cyclotron, the synchro-cyclotron, the synchrotron, and the alternating-gradient synchrotron.

Mr. C. W. Miller's paper on particle acceleration took the work of Cockcroft and Walton as a starting point, and distinguished between direct and indirect acceleration, a full account of the development of both these categories of particle accelerations being given. The development of such machines, he pointed out, pressed the skill of engineers to the limit, as some examples illustrated.

It was obvious that any accelerator must be maintained at a sufficiently good vacuum to prevent scattering of the particles, and although this requirement was perhaps less stringent in linear accelerators than in orbital equipments nevertheless pressures of the order of 10^{-6}mm of mercury were required. In certain cases, for instance in proton accelerators, this pressure had to be maintained in a tank some 40ft long and 4ft in diameter and including a large number of components all providing large areas of surface. Large vacuum pumps were required and indeed accelerator design was providing the stimulus for advanced development of vacuum techniques. In some cases mercury pumps with liquid air cold traps were used and in others high-speed oil diffusion pumps were employed. With these latter it had recently been found that considerable improvement could be obtained using activated charcoal traps, and this was the method which would be used both in the 50MeV proton accelerator and the 25MeV electron equipment at present being made for Harwell. The vacuum problem in any accelerator was made more difficult in that the presence of high electric fields causes stripping of gas from the surfaces and large amounts of gas were evolved when the equipment was first energised.

Mechanical problems played their part and it required little imagination to see the difficulties involved in the manufacture of the outer shell of a 40ft cavity of a proton accelerator and the mounting of this in its vacuum tank. For electrical reasons copper must be used for the cavity, a good surface finish was required to minimise radio-frequency losses and dimensional tolerances of $\frac{1}{16}$in must be maintained. In fact, copper sheet could not be obtained sufficiently large to make this shell in one piece and two sheets had to be used with a circumferential copper weld which must provide a high conductivity joint. Drift tubes had to be mounted in the accelerator and dimensional tolerances both on these components and on their spacing were of the order of 0·001in. The supports for drift tubes had some effect on the radio-frequency fields and it was desirable that they should be as thin as possible. When it was considered that these supports must provide a path for cooling water and also electrical supplies for the magnets and, further, when the weight of a drift tube was some 80 lb, it was seen that this was no easy problem.

The construction of accelerating structures for electron accelerators provided its own problems. Here dimensional tolerances were of the order of 0·0001in and various different techniques had been used. A very good account of the technique used in the Stanford projects has been given by Chorodow, who had used a process of shrink fitting. British techniques had used brazing and clamping schemes. Large mean powers were involved in some accelerator projects and this involved a cooling problem which was made more severe because the temperature of the structure must be maintained constant within a few degrees.

Radio-engineering problems were legion in any indirect linear accelerator programme. The demand for high powers has led to valve development intended immediately for accelerator application but this would obviously influence other applications. The Stanford development of klystrons was a remarkable achievement and this was now being followed by the development of similar valves of somewhat lower peak power but high mean power at A.E.R.E. and Metropolitan-Vickers. These provided the power source for future high-power electron accelerators. For proton accelerators most work so far had been carried out with valves developed for other purposes but A.E.R.E. was now developing high-power triodes for 200Mc/s operation for the 50MeV accelerator. The circuits used with these high-power valves and the modulators for driving them could be considered as an extension of radar techniques and again the skill of the designer was pressed to the limit. Problems were raised even in the power supply to such equipments since the power taken from the mains might be as high as several hundred kilowatts and thus represented a sizable undertaking from the point of view of power engineering and since incorrect operation could cause considerable damage to the equipment the provision of protective devices was of the greatest importance.

A difficulty not always appreciated was that, particularly in a long accelerator, the alignment of the particle path in a straight line might provide great difficulty. Not only were advanced optical methods required for the initial setting of the equipment but reference marks must be made available so that the equipment could be checked periodically for any settling. The mounting of the equipment to minimise settling involved the civil engineer in deciding the construction of the foundation and indeed might involve the geologist in the choice of site.

When small accelerators were used for therapy or industrial radiography mechanical problems of a rather different nature were introduced since for those applications it was necessary for the accelerator to be moved at will to provide beams in the most convenient direction.

Contemporary Particle Accelerators

In reviewing the development of linear accelerators, Mr. Miller pointed out, it had been shown how from early apparatus giving energies of a few keV progress had been made to the present very large equipments providing protons up to 50MeV and electrons up to almost 1GeV. Direct acceleration had been shown to be limited to a few MeV energy but nevertheless, particularly in the form of the Van de Graaff generator, it found considerable application. For higher energy indirect acceleration was used and here energy would seem to be virtually unlimited and in addition large current and hence power could be provided. Since radiation loss, which provided a limitation in orbital equipment, played a negligible part when particles were linearly accelerated, there was no theoretical upper limit to energy and it would seem that the limit was only introduced by economics and by the availability of a sufficiently large number of radio-frequency power sources. Extension beyond the energies yet attained both for protons and electrons was clearly obvious. The Stanford project had been limited only by the difficulties associated with the production and maintenance of klystrons, and it was understood that they were about to embark on an extension beyond 1GeV. As regards protons a design study had been undertaken in connection with the 50MeV accelerator for A.E.R.E. and both the basic physics and many engineering problems considered for extension to higher energy. It had been shown that it would be technically feasible by extending to an overall length of 900ft to produce one μA mean currect of protons at an energy of 600MeV.

Soil Mechanics

The second session continued, after the reading and discussion on particle accelerators, with the presentation of four papers on soil mechanics. They were : "Geology, Soil Mechanics and Civil Engineering," by Mr. H. F. Edmunds ; "The Fundamentals of Soil Mechanics," by Mr. P. L. Capper ; "Soil Mechanics and Railway Civil Engineering," by Mr. A. H. Toms ; and "Soil Mechanics Aspects of the Design of Foundations," by Mr. F. D. C. Henry.

Luminous Flame Radiation

One of the papers in Section A, Physics, of the meeting, which was also presented on Monday morning, may also be mentioned in this account. In his paper "Luminous Flame Radiation," Professor M. W. Thring pointed out that the ability to predict luminous radiation in large heated tube boilers, open hearth furnaces and other flame heated systems was of great importance to the engineer because the extent of luminous radiation might affect the output of the system by a factor of two and the efficiency by 10 or 20 per cent. There was a great gap between fundamental laboratory work on luminous radiation and the knowledge available to the engineer because luminous radiation depended essentially on heat transfer proceeding during combustion, so that it was not possible to scale down the size of the experiment very much.

The expense of building a furnace purely for research had prevented this gap being filled in any one country, but shortly after the war it had been found that by pooling resources, both financial and experimental, between England, France and Holland (see The Engineer, May 7, 1954), the experiments on the required scale could be carried out. A furnace nearly 7ft square and 30ft long had been constructed for the research and a series of experiments had been carried out with it, with up to thirty-five experimental workers taking part in a simultaneous experiment drawn from different countries. These experiments had led to accurate formulæ for predicting the length of the flame, a knowledge of how to improve the efficiency of burners, a knowledge of the effect of fuel type on luminosity, and of the effect of aerodynamic mixing conditions on luminosity.

Steps were now being taken towards the development of a complete formula for predicting luminosity and the range of the work was being extended to new fuels, particularly pulverised coal. The experimental results had also made it possible to develop a theory for predicting heat transfer in the open hearth furnace which had been tested by a special experimental cast on an open hearth furnace.

(To be continued)

The Lord Sempill Paper.—The council of the Institution of Production Engineers has agreed that the opening paper of the annual Aircraft Production Conference, organised by the Southern Section, should in future be known as the Lord Sempill Paper. The object is to commemorate both Lord Sempill's services to the Institution for many years and his life long association with aeronautics.

Helicopter Project.—A forty-seater helicopter, to be known as the "Westminster," is now being designed by Westland Aircraft, Ltd., Yeovil, Somerset. Following Sikorsky principles, the single main rotor will be driven by two shaft-power gas turbines mounted on the cabin top. Of the 3,000 lb all-up weight, 40 per cent is expected to be disposable load. A range of 350 miles, cruising at 190 m.p.h., is anticipated.

Variable Speed, Reversible Hydraulic Drive

A REVERSIBLE variable speed hydraulic drive of Continental design and made in nine sizes with power outputs from 1·25 h.p. to 32 h.p. has been introduced into this country by Churchill-Sturm, Ltd., 27–34, Walnut Tree Walk, London, S.E.11. The seven smaller sizes of drives from 1·25 h.p. to 14 h.p. are designed for an input shaft speed of 1500 r.p.m., and give infinitely variable output speeds up to 2000 r.p.m. on the smallest model and 1180 r.p.m. on the 14 h.p. model. The two largest drives are of 20 h.p. and 32 h.p., and with an input shaft speed of 1000 r.p.m. have infinitely variable output shaft speeds of up to 950 r.p.m. and 750 r.p.m. respectively. These drives give stepless and precise regulation of speed over the full range in either direction of rotation ; the torque being constant up to about one-fifth of the maximum speed and above that the horsepower is constant at all speeds.

Variable speed reversible hydraulic drive unit with pump control lever on the left and motor control hand wheel on the right

The general arrangement of a typical hydraulic unit can be seen in the illustrations we reproduce on this page, and from these the operating principle can be readily followed. The unit consists of an oil pump driven at a constant speed by an electric motor or other prime mover, and this pump drives a hydraulic motor which is coupled to the output shaft. The common casing in which the pump and motor are enclosed also incorporates the hydraulic oil reservoir. Both the pump and motor are of generally similar design and comprise a sliding vane rotor revolving inside a housing carried in a frame. This frame is adjustable transversely inside the casing so that the eccentricity of the housing relative to its rotor can be varied as required. The rotors are mounted on ball bearings and revolve round a fixed central shaft in which are formed channels for oil delivery and return. The housings are also mounted on ball bearings in their sliding frames and are free to revolve in phase with the rotors.

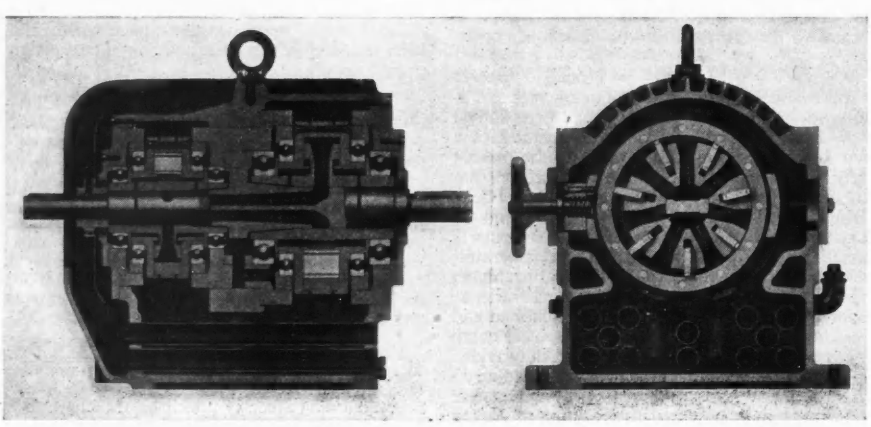
This form of construction reduces frictional losses to a minimum and the design of the rotors and vanes permits the use of high oil pressures. All the moving parts are automatically lubricated, and relief valves fitted in the oil channels protect the mechanism from overloads. A fan mounted on the input shaft provides a constant flow of cooling air along the fins on the top of the casing and through tubes in the lower part of the casing which forms an oil reservoir.

The drive operates on a closed circuit. The pump, on the left-hand side of the unit, forces oil through one channel of the central shaft to drive the motor and the oil discharged by the motor returns through the other channel of the central shaft to the pump. Part of the oil in circulation is bled off continuously to lubricate the bearings and seal the circuit against air infiltration ; oil to replace the amount so used being drawn from the reservoir. Normally two controls are fitted, one for the pump and the other for the motor, but, if required, a single lever or handwheel can be fitted. When the controls are in their stop position the pump housing is concentric with its rotor, so that there is no displacement of oil to drive the motor which remains at rest. When the lever controlling the position of the pump housing is operated the housing is moved into an eccentric position in respect to its rotor. Oil under pressure then begins to flow to the motor. The housing of the motor is at this stage at its maximum eccentric setting in respect of its rotor, and the motor begins to rotate. As the eccentricity of the pump housing is increased the amount of oil delivered to the motor increases proportionately, and as the motor housing remains at maximum eccentricity the speed of the motor also increases steplessly at the same rate. By the time that the pump housing reaches its maximum eccentricity the motor speed has risen to about one-fifth of its maximum rating and the motor is developing its full horsepower ; during this period the torque, which depends directly on the eccentricity of the motor housing, remains constant.

From this stage onwards the pump housing setting remains at maximum eccentricity, so that the volume of oil delivered to the motor, and therefore the horsepower developed, remains constant. The speed of the output shaft can now be increased by reducing the eccentricity of the motor housing ; the torque falls off proportionately while the power output is unchanged. The maximum speed is reached when the eccentricity of the motor housing is reduced to about 20 per cent.

To reverse the direction of rotation of the output shaft it is only necessary to move the lever controlling the pump housing the opposite way. This changes the eccentricity of the housing relative to the rotor from one side to the other, which reverses the direction of the oil circulation and consequently the direction of rotation of the motor. The action of the pump is the same whichever way the housing is moved, so the motor has the full range of speed and power no matter which way it is running. With the input shaft running and the controls in the stop, or neutral, position there is a strong braking effect on the output shaft.

The makers state that the efficiency of the drive is virtually constant at all normal operating speeds, varying from 68 to 72 per cent at half load and from 75 to 80 per cent at full load. For use where lower speed ranges are required drives can be supplied with built-in reduction gearing. The drive can be supplied in various forms to suit particular machines, the standard unit being designed for interposing between the driving motor and the machine, to which it is connected through flexible couplings. It is also made as a combined set, with a motor mounted on a base-plate above the unit and driving it through pulleys and vee belts, or with a flange-mounted motor directly coupled to the input shaft. If required, the drive can be arranged for building into a machine.



Arrangement of the pump and motor assemblies in variable speed hydraulic drive. On the right can be seen the hydraulic motor with the hand wheel for setting the eccentricity of the housing

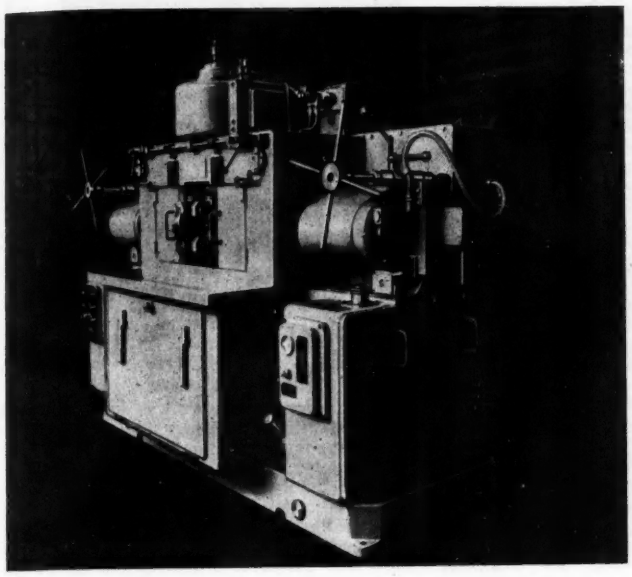
Conference on Stresses and Displacements in Structures

THE Institution of Civil Engineers has arranged a conference, to be held this month, on September 21st and 22nd, on "The Correlation Between Calculated and Observed Stresses and Displacements in Structures." The papers have been placed in four groups, according to their subject, and will be presented as a group by a general reporter. The papers are: Group I, Philosophy and Techniques of Testing, general reporter, Professor S. C. Redshaw : "Some Factors in the Field Testing of Structures," by F. G. Thomas ; "Site Strain Measurements : Some Philosophical Aspects," by A. Goldstein ; "Techniques for Field Measurements of Deformation and Earth Pressure," by W. H. Ward. Group II, Steel Structures, general reporter, J. F. Pain : "Testing of Prestressed Steelwork," by R. A. Sefton Jenkins ; "Loading Tests on Bridges," by F. G. Thomas ; "Stress Measurements in the Steel Frame of the New Government Offices, Whitehall Gardens," by R. H. Wood and R. J. Mainstone ; "The Behaviour of Saw Tooth Portal Frames," by Professor J. F. Baker and K. G. Eickhoff ; "Some Experiments on Clifton Suspension Bridge," by A. R. Flint and Professor A. G. Pugsley ; "Tests to Destruction on a Vierendeel Girder," by Professor F .B. Bull ; "Full-scale Loading Tests on a Welded Plate-girder Floor System," by B. E. S. Ranger and Jacques Heyman ; "The Design of a Raw-Sugar Silo," by E. T. Moss. Group III, Concrete Structures, general reporter, Professor A. L. L. Baker : "Telephone Manager's Office, Kilburn," by H. C. Adams, S. C. C. Bate, and F. Walley ; "Site Strain Measurements : Examples of Prestressed Concrete Structures," by A. Goldstein ; "Loading Tests on the Floor Systems of a Reinforced Concrete Building," by A. J. Ockleston ; "Load Tests on a Small Prestressed Concrete Highway Bridge," by P. B. Morice and G. Little ; "The Deflection of Reinforced Concrete Portal Frames with Sloping Rafters," by W. C. Andrews and E. F. Whitlam ; "Test of a Precast Prestressed Shell Roof," by J. J. Lewkowicz. Group IV, Earth Pressures and Movements, general reporter, H. Q. Golder : "Settlement Studies on Structures in England," by L. F. Cooling and R. E. Gibson ; "A Survey of Comparisons Between Calculated and Observed Settlements of Structures on Clay," by D. H. MacDonald and Professor A. W. Skempton ; "A Review of Comparisons Between Measured and Calculated Earth Pressures," by W. H. Ward.

Piston Gudgeon Pin Hole Drilling Machine

PARTICULARS have been received from Adcock and Shipley, Ltd., Ash Street, Leicester, of a machine recently built by the firm for Humber, Ltd., for drilling gudgeon pin holes in pistons. It has been designed to combine a high production rate with safety in operation and a minimum of operator fatigue.

As can be seen in the accompanying illustrations, the machine is a horizontally opposed



Machine for drilling gudgeon pin holes in pistons at one station of its fixture whilst the second station is being reloaded

design with two multi-spindle drilling heads, one on each side of a central, two-station, rotating fixture. On it two components are drilled at one station of the fixture whilst loading and unloading of the pistons is carried out at the other. Indexing of the fixture and clamping of the components is effected by hydraulic power. The indexing operation is initiated by the opening of two doors set on each side of the fixture, and these doors when closed prevent access to the spindles during drilling. Clamping of the components is controlled by two levers above the fixture and operation of these levers also controls the locking and unlocking of the doors. In the drilling cycle, which is started by depression of a push button, the drill heads are automatically fed into the work, retracted and stopped.

Safety factors incorporated into this machine are the necessity of two handed operation of both the indexing and clamping mechanisms, and a further safeguard is the fitting of two doors which cover both cutting tools and workpieces during the drilling cycles.

One of our illustrations shows the outer stations of the fixture with the components in position and clamped. The pistons, when loaded on to the fixture block, are located on the bore and supported internally by a pair of fingers locating on the gudgeon pin hole. The components are held by a vertical clamping bar fitting securely over their crowns. When unclamped this bar moves clear of the components and pivots through 90 deg. into a horizontal position, giving adequate clearance for on and off loading.

In the sequence of operations two drilled pistons are unloaded and two blanks loaded on the front station of the fixture. Then, on the two levers above the fixture being operated, the components on the front station are clamped and the two doors are unlocked. On these two doors being opened their movement indexes the fixture through 180 deg. to carry the piston blanks to the drilling station at the rear and those which have been drilled round to the unloading and loading station at the front. The doors are then closed and on the levers being again moved the doors are locked and the clamp on the front station of the fixture is unlocked. The drilling cycle is then started by depression of the push button, and whilst it is proceeding unloading and re-loading of components is carried out at the front station.

The machine is fed hydraulically by a servo-mechanism operated from cams rotated by a separate feed motor with a drive equipped with pick-off gears to enable cycle times to be changed.

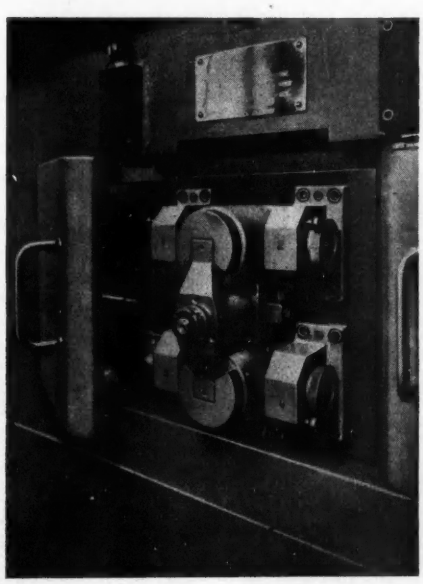
The horizontally opposed two-spindle drill heads mounted on slides on the cabinet base are individually driven by 2 h.p., 1430 r.p.m. motors. In the heads, 0·854in diameter drills are fitted to standard collets, each having individual adjustments of 1in. The drill heads have a hand adjustment of 6½in by means of capstan type wheels.

When drilling, the heads advance at a fast traverse rate of 300in per minute and then change down to a drill feed rate of 0·008in per revolution of spindle at 820 r.p.m. Drill speeds and feeds can be varied by means of pick-off gears, and provision is made for hand feeding, indexing and clamping for testing and setting up purposes.

The machine consists of a base acting as a coolant reservoir and mounted upon it is a box section containing the hydraulic control mechanism. On the left and right of the base are two cabinets extending forward. The left-hand cabinet fronted by a switch panel contains the electrical control gear and the right-hand cabinet contains the hydraulic power unit.

Lubrication is by a "one-shot" system to the drill head slides and is operated by a foot pump near floor level at the front of the machine. Coolant is fed by a large-capacity centrifugal pump mounted in the base to guide bushes in the fixture and supplied in powerful jets to the cutting tools.

Special attention has been given to the problem of swarf accumulation, the front of the machine being equipped with a large sheet metal cabinet



Outer station of indexing work fixture with components clamped and door being opened for indexing operation

in which coolant and swarf is collected in a special swarf barrow. The bottom of the swarf barrow is fitted with grids to enable coolant to drain out and the front of the cabinet is hinged at the bottom to allow the barrow to be pulled out on its wheels and replaced by a similar barrow.

Report on Derailment at Sutton Coldfield

THE report by Colonel Wilson on a derailment of a passenger train at Sutton Coldfield on Sunday, January 23, 1955, was issued last Wednesday. The train concerned was the 12.15 p.m. express from York to Bristol via Sheffield, Derby, Burton-on-Trent and Birmingham, comprising ten bogie coaches hauled by a 4–6–0 type mixed traffic engine. It had been booked to run between Wichnor Junction (south of Burton) and Birmingham on the secondary line via Lichfield and Sutton Coldfield, owing to routine permanent way renewals on the usual main line route to Birmingham via Tamworth; the train driver, who was stationed at Gloucester, was unfamiliar with the Sutton Coldfield route, so a local driver had joined the engine at Burton to act as "conductor" as far as Birmingham. The speed, however, was not reduced at Sutton Coldfield in accordance with the permanent "Appendix" restriction of 30 m.p.h. which is in force through the station on account of the severe left-handed curvature, and the train entered the curve at 55–60 m.p.h., with the result that the engine and all of the coaches except the tenth were derailed to the outside of the curve between the platforms. The engine and tender were overturned and there was heavy damage to the rolling stock, which included the destruction of the first, fourth and fifth coaches. There was also considerable damage to both the platforms and to the tracks between them, and a part of the down platform awning was carried away. There were about 300 passengers in the train, and seventeen persons lost their lives; twelve passengers, the conductor-driver and the fireman were killed outright, and two passengers and a driver travelling on duty subsequently died of their injuries in hospital. In addition, forty passengers were taken to hospital, seventeen of whom were discharged the same afternoon after treatment; twenty-three passengers were detained, some with very serious injuries, also the regular driver of the train, who was not on the engine at the time, and a goods guard, who was travelling on duty.

Colonel Wilson finds that the derailment was brought about by excessive speed, that the excess of speed was too great to be accounted for by misjudgment and that Driver Allen, the conductor-driver, made no attempt to observe the 30 m.p.h. restriction at Sutton Coldfield. In his recommendations Colonel Wilson, after discussing lineside speed restriction notices and observing that had such signs been in position they might have acted as a direct reminder to Driver Allen, goes on to write:

"British Railways are now entering an age of more precise working, with diesel and electric locomotives fitted with speedometers, as also are all new passenger and mixed traffic steam locomotives. It should, therefore, be possible in the future to regulate speeds more closely to permissible limits, and there is little doubt that as a result the civil engineers will be pressed to raise their restrictions as much as possible. Higher maximum and average speeds are also envisaged. Furthermore, the training of the driver in the future will probably be different from what it was in the old steam days, with fewer years of running experience, and engine runs may be longer with a greater strain on memory to recollect all the features of a route. Nor should it be overlooked that, with the more intensive use of engines, drivers are now required to have a knowledge of more routes than in the past. All these factors make it necessary to consider whether the past general practice of relying on memory for the observance of speed restrictions should not be changed, and a uniform procedure adopted for defining clearly the position and degree of speed restrictions by line-

side signs. I recommend that this question should again receive the attention of the British Transport Commission, and at the same time I would observe that the practice of the former London and North Eastern Railway of using unlit signs at the beginning and end of restrictions has much to commend it. It might also be desirable to consider whether speed recorders would not be preferable to speedometers. The former not only indicate the speed to the driver at any instant, but also provide a permanent record of the speed of the train throughout its journey. Records of this type have proved to be valuable in maintaining a high standard of performance in other countries, and with the contemplated introduction of higher speeds on British Railways it might be prudent to provide the more elaborate equipment."

Frankfurt Battelle Institute

THE Battelle Institute in Frankfurt/Main, which was opened on June 12, 1953, and commenced its work in October of that year, is at the present time the most important of the European Battelle centres.

It is a non-profit-making undertaking devoted to sponsored industrial research, and employs a staff of 279 persons. Its growth has been rapid. Comprising 116 persons at the beginning of 1954, the staff had increased to 211 by the end of the year, of whom 53 per cent were scientists and technologists, 32 per cent technicians and craftsmen, while the remaining 15 per cent were administrative personnel. It may be of interest here to give a brief outline of the development of the Battelle organisation.

The parent institute in Columbus, Ohio, was founded in 1929 under the will of Gordon Battelle, an American industrialist who left very substantial sums for the endowment of industrial research. Commencing with a staff of twenty, the institute has substantially increased over the years. It became fully self-supporting in 1939 and now it and a smaller laboratory at Daytona Beach, Florida, employ some 2200 people. In Europe, the first Battelle laboratory to be opened was the one at Geneva. Including the Geneva and Frankfurt laboratories, and the technical offices maintained in those towns and in London, Madrid, Milan and Paris, the total number of staff to-day is in the region of 2600. The position of Battelle as compared with other American research foundations may be seen from the following table :—

Research Foundations in the United States (1953)

Name	Annual turnover (million dollars)	No. of employees
Battelle Memorial Institute ...	15·3	2200
Armour Research Foundation...	11·2	2100
Cornell	10·3	1109
Stanford	7·7	1052
Mellon	4·4	650
Southwest	3·8	461
Franklin	2·9	410
Mid-West	1·8	218
Southern	1·15	149

The Frankfurt Institute deals with problems affecting mechanical and chemical engineering, and is organised in ten departments of which five are devoted to specific lines of research.

Of these the one concerned with mechanical engineering carries out work in connection with the design and construction of apparatus, unit operations, transmissions, hydraulics, engine research, optical stress analysis and strain measurements.

There is a metallurgy department where work is done, both with regard to ferrous and non-ferrous metals, on foundry techniques, metal processing and heat-treatment, powder metallurgy, metallography, strength testing, including creep and fatigue tests, finishes and corrosion, and physical metallography.

The ceramics laboratory carries out researches on refractories, earthenwares and porcelains, electro-ceramics, oxides, glasses and enamels, structural clay products, and technical processing.

In the physics department, instrumentation and measuring techniques are developed, and work is carried out on problems involving electronics, the physics of solids, optics, controls, electron microscopy, and X-ray diffraction.

Finally, there is a chemical laboratory, which deals with organic and inorganic chemistry, physical and electro-chemistry, analysis spectrography, pharmacology and industrial toxicology, plastics, paints and lacquers, unit operations, and radio-chemistry.

These divisions are supplemented by a Central Research Department which has a double function in that it carries out chemical analyses, electron microscopy and X-ray crystallography, and is responsible for the measuring instruments as well as being in charge of the library and of literary and patent matters, both as an internal service for other departments and for outside customers. The library at present comprises 8000 volumes and 500 current specialist journals from which photostat copies can be ordered. It is intended to expand the library to about 25,000 volumes.

Another section, the Economic and Administrative Department, has also both an internal and external function. It handles the commercial and administration problems of the Institute staff, but also carries out market research and analyses for customers.

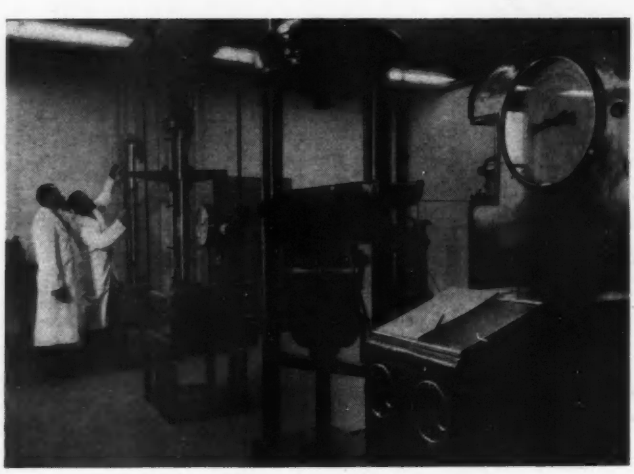
The technical side of the running of the Institute is the duty of the works department. There is a public relations department, which handles outside contracts.

Lastly, the Contract Progress Department, which acts, so to speak, as sales department, is concerned with the carrying out of contracts from the first inquiry to the final report. The conditions under which work is done have been fully standardised and a description of the considerations and procedures which operate will now be given.

Lecture theatre

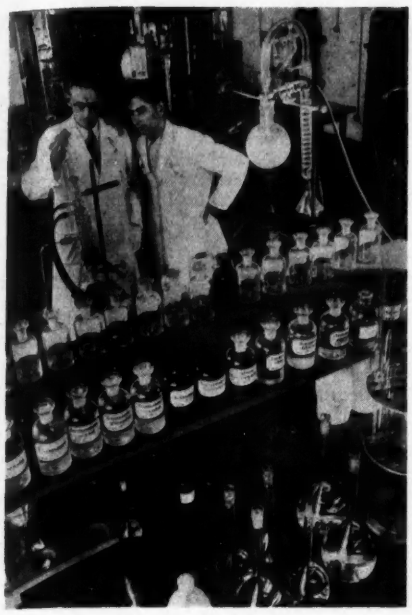
The basis of all work is a research contract which is drawn up by the Institute on the basis of preliminary discussion and defines the problem, the duration of the work, and the maximum cost to the sponsor. This cost is made up of salaries, expenses for materials and supplies, special equipment, travel and freight charges, and direct overheads, as well as indirect overheads calculated as 45 per cent of the cost of the other items. This maximum cost may not be exceeded by the Institute without a fresh agreement, but if it is not reached the sponsor is liable only for the actual cost incurred. Progress reports are made periodically upon the work which, of course, is strictly confidential at all stages, and the contract sets out the procedure to be adopted when patents are to be applied for. All inventions made are to be placed for a stated period at the disposal of the sponsor on whose behalf the Institute will apply for German patents if requested to do so. The question of inventors' compensation is subject to the German law on employee-inventors, and with regard to this and other problems such as that of foreign protection, the Institute undertakes to assist the sponsor by making available information and in other ways. All costs arising from patent applications are additional to the cost of the research fixed in the agreement.

Since the results of any research carried out



40 tonne, 20 tonne and 3 kg testing machines

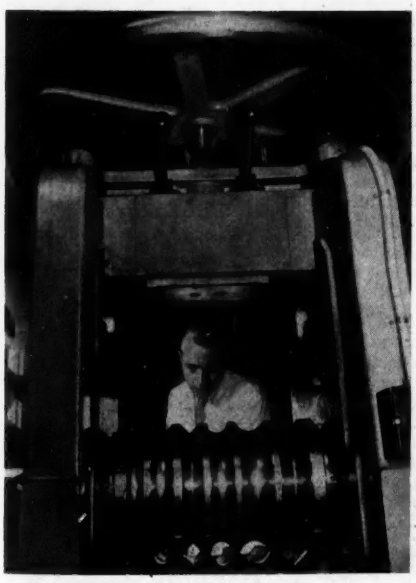
10 kc/s induction furnace for 150 kg charge



Chemical laboratory

are at the disposal of the sponsor, and no information in relation to the work may be divulged without the sponsor agreeing, it follows that any particular research problem can be investigated only once by the Institute. The question of priority is referred to the Co-ordination Bureau, set up in 1929 in Ohio. When clearance has been obtained, the draft contract is sent to the sponsor, who thus obtains an option on the research theme, without obligation, for the period for which the contract remains open for his signature.

In order to carry out its functions efficiently, the Institute was constructed to somewhat unusual specifications. There are two buildings on the Frankfurt site which provide a total floor space of 15,500 square metres (168,000 square feet), one a reinforced concrete structure, the other a steel-frame design. Both are constructed to a module of 4m by 7m. There are no supporting internal walls. Partitions consist of "Ytong" blocks, a lightweight material which is easily sawn, drilled or nailed into, and is a good insulator of heat and sound. The choice of this material, together with the fact that the walls are not rendered with plaster, but merely distempered, makes it possible to reconstruct a laboratory, to suit the work, within a matter of hours.



Experimental rolling mill

Currents of up to 600A may be obtained by plugging into a busbar system at distances of 40cm, and supplies of hot and cold water, compressed air and town gas, and drainage are in common to every two 4m sections of the building. Rails let into the ceiling enable lights to be suspended where required, the wiring being laid on the bare wall, and there are facilities for air extraction in each space unit. Load capacity of the floors is 2 tonnes per square metre in the upper storeys, and 3 tonnes per square metre on the ground floor. There are two 2-tonne cranes, and one of 5 tonnes for the handling of heavy equipment.

The accompanying illustrations show the equipment in various departments of the Institute.

Stuttgart Television Tower

THE accompanying illustration shows the transmitter tower of the Süddeutscher Rundfunk, Stuttgart, the construction of which has recently been completed. The tower is situated on the Hoher Bopser (482m) near Degerloch. It carries the aerials of the Stuttgart television and ultra-short wave transmitters. A four-storeyed building at the top of the tower houses the transmitter station, as well as a restaurant, and has a flat roof which serves as an observation platform, with a second platform surmounting it. The top of the aerial is 211m above the ground, or 693m above sea level.

The 7·50m deep foundations consist of a prestressed concrete plate, 27m in diameter and specially reinforced at the centre and at the rim, which carries two mutually inclined concrete shells. These shells in turn have superimposed upon them a plate 1m thick which forms the

Stuttgart television tower under construction

base of the tower itself. The latter is a reinforced concrete structure of conical shape, tapering from a diameter of 10·80m at the base to 5·10m at a height of 136m, at the underside of the basket-shaped building at the top. Wall thickness also decreases from 0·80m at the level of the entrance to 0·30m at the 10m level, and only 0·19m at a height of 136m.

Inside the tower and up to a height of 75m there are half-floors at every 20m, and cross-beams every 10m, as supports for the emergency staircase which from 75m to the top is in the form of a double iron staircase. Two 1200 kg lifts, which can attain speeds of 4m per second, and carry a total of sixteen people each, enable 807 people per hour to be brought to the top, or if traffic is in both directions, convey 658 people per hour.

The building which, as already mentioned, commences at 136m height, has accommodation for the transmitters (floor level 138·10m), a kitchen and ancillary rooms at 141·30m and two floors of restaurant span at 144m and 147m. In diameter the building varies from 12·30m at the transmitter station to 15·00m at the top, which has been arranged to serve as the main observation platform (150m above ground). It is surmounted by a second, smaller, platform at 152·40m level, the engine-house for the lifts and the lattice-work aerial mast.

The building has window frames made of light alloy, with fixed glazing, and is fully air conditioned, the interior being kept slightly pressurised.

Of a total weight of 4500 tonnes of the complete tower, about 1500 tonnes are foundations. A load carrying capacity in the subsoil of 3·6 kg per square centimetre, is not reached by the design. A gradual even settlement amounting to about 3cm is anticipated, together with a shrinkage of some 6cm in the first three years. In a gale of 47m per second (Beaufort 11–12), the tower will deflect 30–35cm at platform level, while the top of the mast will deviate from the vertical by up to 150cm, period of one complete oscillation being six seconds.

Because of the change in length of the tower and the pipes, both hot and cold water pipes must accommodate a certain amount of compression. The cold water mains are constructed to withstand a pressure of up to 30 atmospheres gauge.

About 110–130 people can find room on the top platform, and 220–300 on the main platform. The two restaurant floors, together, hold about 220 persons.

One-half of the bottom storey is occupied by a television transmitter for band III, leaving sufficient room for the installation at a later date of another transmitter, e.g. for band IV. Advantages of arranging the transmitter close to the aerial are reduction in cable losses and better picture quality. If the transmitter were at the foot of the tower, it is stated that losses in the aerial feeder cable would amount to 20 per cent of the total energy.

Thermal Insulation and Heat Loss Calculators

To provide a quick and simple means of determining the economic thickness of thermal insulating materials and the heat loss from round or flat insulated surfaces, two calculating slide rules have been developed and placed on the market by Potter's Insulations, Ltd., Tameside Mills, Park Road, Dukinfield. The slides on these calculators are set using the basic data normally required and the answers can then be easily read off the adjoining scales. In connection with the insulation thickness calculator the makers point out that for strict accuracy an individual calculation would be necessary for each set of conditions, but the thicknesses given are sufficiently reliable for commercial requirements and only at the extreme ends of the scale do they vary slightly from the theoretical figures. The operation of the heat loss calculator is based upon the standard formula and, as with the insulation thickness calculator, full working instructions are clearly given on the back of the instrument. These calculators can be used for multiple-layer as well as single-layer insulation, when calculating economic thicknesses, heat losses and interface temperatures.

BUILDING AND CIVIL ENGINEERING BY LOCAL AUTHORITIES IN 1951.—A Board of Trade report published by H.M. Stationery Office concerns building and civil engineering work carried out by local authorities in 1951. The report is part of the series in the census of production in 1951, and contains tables giving a statistical summary of direct labour works carried out by local authorities.

Industrial and Labour Notes

T.U.C. and Industrial Disputes

At the annual assembly of the Trades Union Congress, at Southport last week, the general council's proposed amendment to the rules about intervention in industrial disputes was debated on Tuesday. The object of the amendment, it was stated, was to enable the general council—if in the light of all the circumstances it seemed advisable to do so—to interest itself in a dispute before negotiations had actually broken down and deadlock had been reached.

The amendment was introduced by Sir Vincent Tewson, general secretary of the T.U.C., who said that this country's system of industrial relations and collective bargaining solved all but a small fraction of labour problems. When the T.U.C. had been asked to intervene in disputes in the past, often those disputes had already reached a serious stage. There was no intention, Sir Vincent continued, of destroying the autonomy of individual unions, and the T.U.C. general council would not assume dictatorial powers. What was proposed was that the unions should accept some moral persuasion and that the general council should be allowed some initiative.

The principal opposition to the general council's amendment came from Mr. F. Foulkes, president of the Electrical Trades Union, who claimed that the object of the T.U.C.'s rules was to create a fighting trade union machine when an individual union was faced with the position of having to surrender or fight. Mr. Foulkes considered that the general council's amendment would lead to negotiations between the T.U.C. and employers ; if a particular union did not like a settlement reached in that way, it would be at a disadvantage.

The amendment was carried by a clear majority.

Wages and Hours

Another important debate at the Trades Union Congress last week was concerned with wages. The congress approved a resolution emphasising the right of unions to protect and improve their members' wages and working conditions.

The debate was introduced by Mr. W. L. Heywood, chairman of the T.U.C. general council's economic committee, who said that the government should state more clearly its intentions concerning the economic situation. If incomes rose more quickly than productivity, prices would rise and Britain might be priced out of the export market. But, Mr. Heywood commented, labour costs were no more relevant than gross trading profits and interest payments, and profits for each unit of output had increased just as much as labour costs. Nevertheless, he continued, wage claims were being submitted rapidly and the unions could not go on "pushing one another around" while the balance of payments deteriorated. The government's culpability did not absolve the unions from responsibility and union executives must reflect on the economic situation. Some ten years after the first world war, Mr. Heywood added, 20 per cent of trade union members had been out of work. The unions must see to it that nothing which they did imperilled full employment and the relatively high living standards gained for their members.

On the subject of working hours, a resolution was submitted expressing alarm at the growing extension of the working week. While recognising the need for occasional overtime work, the resolution called for a drastic reduction of systematic and excessive overtime and for a "vigorous campaign" to achieve the forty-hour week. One speech in support of this resolution declared that working hours in Britain were longer than in other European countries, and that the amount of overtime worked was injurious to health. Workers, it was added, were beginning to accept it as a normal condition of employment and employers were offering unlimited overtime as an attraction in their advertisements of vacancies.

On behalf of the T.U.C. general council, Mr. W. L. Heywood said that although the forty-hour week was the policy of many unions, it should be pressed at suitable and appropriate times. He asserted that if it were demanded now employers would have to expand their premises and take on more workers at a time when there was less unemployment than there had ever been since statistics were collected, and a serious shortage of labour in many industries. A forty-hour week now would simply mean more overtime work. The general council, Mr. Heywood said, believed that regular overtime was unavoidable in some sections of industry and therefore asked that the motion be remitted to it. The movers of the resolution refused to agree to its remission to the general council, but when a card vote was taken subsequently the resolution was rejected.

Employment and Unemployment

The Ministry of Labour has reported that, at the end of July, the number of people in civil employment in Great Britain was 22,945,000 (15,185,000 men and 7,760,000 women). This was 50,000 more than at the end of June and 290,000 more than at the end of July 1954.

Of the July total, 4,021,000 were at work in the basic industries, the increases during the month occurring in transport and agriculture. In the coal mining industry, there was a further decline of 2000 in the number of wage earners on the books, the total at the end of July being 702,000. In the manufacturing industries, the number employed at the end of July was 9,228,000, denoting a net increase of 6000 during the month. The increase was in the food and drink industries, there being small decreases in almost all the other manufacturing groups. In the engineering, metal goods and precision instruments group the number employed declined by 4000 to 2,760,000, a figure which was 134,000 higher than that returned at the end of July 1954. In vehicle building, there was a drop of 1000 to 1,234,000, compared with 1,176,000 a year earlier. In industries outside the basic and manufacturing classifications, one increase that occurred in July was in building and contracting where there was an addition of 9000 bringing the total labour force to 1,475,000. There was also an addition of 12,000 to the number engaged in "professional, financial and miscellaneous services," making the total employed in those services 4,104,000.

In its latest report on unemployment in Great Britain, the Ministry of Labour states that on August 15th there were 199,693 people registered as out of work, compared with 184,929 on July 11th. It is estimated that the figures for both months represented 0·9 per cent of the total number of employees. The Ministry says that the increase of 15,000 in the unemployment figure between July and August consisted mainly of school-leavers who were registering for work. The number of vacancies notified to the employment exchanges but still unfilled on July 27th was 473,000 ; this was 90,000 more than a year previously and the highest number of vacancies outstanding since August 1951.

Coal Production Inquiry

At the end of last week it was stated that the National Coal Board and the National Union of Mineworkers had agreed to undertake jointly an investigation, at pit level, into the possibilities of increasing coal output. This decision was reached at a meeting, held at Southport, attended by Sir Hubert Houldsworth, the chairman, and two other members of the National Coal Board, and Mr. W. E. Jones, the president, and the vice-president and general secretary of the National Union of Mineworkers. It is understood that the inquiry is to begin immediately, the principal object being to find out how output can be increased at pits where it has recently declined.

After the meeting at Southport, the National Coal Board issued a statement expressing regret that the National Union of Mineworkers had not yet decided whether it was prepared to recommend the acceptance of foreign workers. The Board described the situation as one of "grave urgency" and said it was satisfied that the acceptance of foreign labour was the only way of meeting the critical manpower needs of the industry and of maintaining production. If foreign labour was not accepted, the statement added, the Board would be placed in a most difficult position. It would seek to alleviate the situation by continuing its policy for the better deployment of manpower ; the introduction of power-loading machinery at the coal face and other mechanical devices ; the reduction of wastage, and its policy for recruitment. But, the Board said, the manpower problem and the consequences thereof would remain acute. The statement emphasised that the Board welcomed the offer of the National Union of Mineworkers to join in the "wastage and deployment" inquiries. But the Board stressed also that it would welcome the union's co-operation in increasing the mobility of labour between pits, eliminating restrictive practices, and reducing absenteeism.

Industrial Health Survey

On the recommendation of the Industrial Health Advisory Committee, the first of two industrial health surveys is shortly to begin in Halifax. It is stated that this is part of the Ministry of Labour's plans for promoting the health and well-being of factory workers throughout the country. At a meeting at Halifax last week to discuss the survey, Sir George Barnett, Chief Inspector of Factories, said that the advisory committee had recognised that much could be done at national level to stimulate the development of industrial health services. But it was also recognised, Sir George stated, that if the needs of workers in smaller factories were to be catered for adequately, much of the necessary action must be taken on a local basis and must depend on local initiative and enthusiasm for its success.

The Industrial Health Advisory Committee has recommended that, before any general scheme of surveys is started, two pilot surveys should be carried out to test fact-finding methods. Halifax has been chosen for the first of these surveys in view of the fact that it is a medium-sized town with a diversity of industries. The survey is to be made by a team of factory inspectors. This team will inspect every factory in Halifax, studying environmental conditions, including such matters as cleanliness, overcrowding, heating, ventilation and lighting. In particular, the team will examine any processes which may give rise to specific health hazards and will note the precautions taken. A local advisory committee for the survey will include representatives of employers' organisations, trade unions, and the medical profession. All the information in respect of individual firms will be treated as confidential. A report will be submitted to the Chief Inspector of Factories giving for each industry an assessment of the standard of conditions and details of health hazards, together with an appraisal of the need for preventive measures.

Overseas Trade

The preliminary figures issued by the Board of Trade concerning the United Kingdom's overseas trade in August indicate recovery from the effects of the dock strike in June and the early days of July. Export figures for August are usually low, on account of holidays, but this year the value of August exports is put at £264,200,000. Imports recorded for August were valued at £342,400,000, the average monthly rate of import for June, July and August being £325,100,000, compared with a rate of £322,300,000 between January and May. Re-exports in August were valued at £10,000,000. The excess of imports over total exports in August was £68,200,000, compared with £107,800,000 in July and £128,900,000 in June.

Dual-Cycle Boiling Reactor

BY OUR AMERICAN EDITOR

The Nuclear Power Group, Incorporated, recently announced its intention to build a 180MW nuclear generating station in Illinois, which is to be operated by the Commonwealth Edison Company. Thermal energy for this power station is to be supplied from a General Electric dual-cycle boiling reactor, the principle of which is described in this article. This new reactor is expected to retain the inherent safety of the direct-boiling reactor, but can be constructed in much larger sizes for power plant applications.

IN most nuclear reactor systems, heat is removed by a circulating liquid, such as water. Such plants usually have a heat exchanger for steam generation situated between the reactor and the turbine. The first water-cooled reactors have used hot water under pressure to remove heat from the nuclear fuel. In such reactors this cooling water is pumped through a heat exchanger where its heat is used to boil water, under lower pressure. Steam from the heat exchanger is then used to operate the turbine. High-temperature water is an excellent heat transfer medium, permitting the removal of large quantities of power from comparatively small reactors. For this reason liquid-water-cooled reactors have found application where high power output is required from a small plant, such as in naval propulsion applications. However, other aspects of the design are not attractive for some applications. In order to suppress boiling, high pressure is used in the reactor. This factor, coupled with the temperature loss in the heat exchanger, results in the use of a reactor pressure three to five times higher than the steam throttle pressure. To accomplish this thick-walled pressure vessels and piping are needed.

Model of dual-cycle boiling reactor exhibited at the recent conference at Geneva

Simple Boiling Reactor

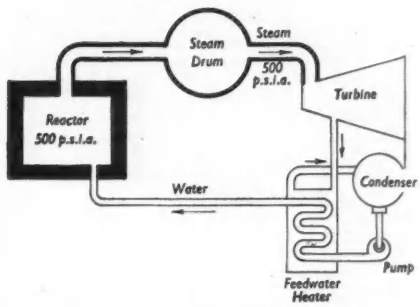
After intensive study of the main disadvantages of the liquid-water-cooled reactor, the Argonne National Laboratory developed a new concept, which was to generate the turbine steam directly in the core of the reactor, instead of in a separate heat exchanger. This idea represents the simple boiling reactor where heat produced in the fuel rods is used to generate steam within the reactor itself. This steam is then used directly in the turbine. A 5MW-electric generating plant of this design is under development at the Argonne National Laboratory as part of the current five-year programme of the U.S. Atomic Energy Commission. A heat exchanger is not required by this simple system. The pressures and temperatures in the reactor are much lower, and the pressure in the reactor need be little greater than the turbine throttle pressure. For a given coolant temperature in the reactor the thermal efficiency of this system is much higher than that of the system using hot water and a heat exchanger. For a reactor temperature of, say, 500 deg. Fah. the gain in efficiency is claimed to be 16 per cent.

Tests have also shown that the boiling reactor system provides an unusual degree of inherent safety. In the event of a reactivity excursion a boiling reactor core fills with steam. Since the neutron moderation of the water is required to sustain the chain reaction, the reactor, in effect, quenches itself. Thus, boiling reactors are safe reactors. On the other hand, there are definite limits to the power output per unit volume of a direct boiling reactor. As the water boils its density fluctuates, and any density change will affect the moderation of neutrons. In consequence, the power level will fluctuate unless the maximum steam void fraction is limited to that which smooth operation can achieve. It is probably not feasible to control more than a few per cent reactivity with steam voids. In a simple boiling reactor this practical limit may correspond to some 20 per cent of steam voids, averaged through the reactor core. For a small reactor where the length of steam travel through the core might be as low as 2ft, a reasonable power density per unit volume can be achieved without exceeding 20 per cent steam void fraction. Where the steam path is lengthened to 8ft to 10ft, as in large reactors, the power density that can be produced from a simple boiling reactor is reduced to such a low value that unreasonable reactor sizes result.

Another difficulty may arise from the behaviour of a boiling reactor during a change in load demand. A sudden increase in load demand will increase the steam flow from the reactor, causing a reduction in pressure, which will result in flashing water into steam with the reactor. This steam will serve to reduce the reactivity, and hence the reactor output will tend to fall just when more power is needed. Thus the simple boiling reactor is not self-regulating, and reactor control adjustments are required to match load variations.

Dual-Cycle Boiling Reactor

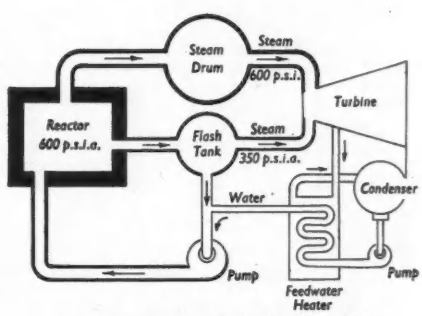
Thus, the problem was to find a reactor system which would preserve as many of the boiling reactor's assets as possible, yet avoid its disvantages. In the dual-cycle boiling reactor, which has now been developed by the General Electric Company, of Schenectady, New York, sub-cooled water is obtained from a flash tank system, operating in conjunction with the boiling cycle (the flow cycles of the two systems are shown in the diagrams). Assuming that 600 lb per square inch absolute has been selected as the operating pressure within the reactor vessel, the flash system operates to produce steam at 350 lb per square inch absolute, which is admitted to an intermediate stage in the turbine. In the flash system water from the reactor passes through the flash vessels where pressure is reduced, thereby



Diagrammatic arrangement of simple boiling reactor

causing a fraction of the water entering the flash tank to be converted into steam, while the remainder is cooled. This water is then pumped back into the reactor, to provide the sub-cooling required. This dual cycle succeeds in overcoming the two main limitations of the simple boiling reactor : low power output for a given size and poor stability under load variation. It preserves a large amount of natural circulation and employs much of the very simple equipment of the basic boiling cycle. There is some compromise of the thermal efficiency gains theoretically obtainable in the simple boiling reactor, although this cycle maintains a thermal efficiency advantage over liquid-water-cooled reactors. The major safety advantages are as effective in the dual cycle as in the simple boiling reactor.

The really important advantage of self-stabilising reactor power with load variations is attained in the following way : most of the turbine governor adjustment for load variations takes place in the 350 lb per square inch absolute steam admission. Consequently, the sub-cooling in the reactor increases with load. When there is a demand for more power, the turbine governor acts to admit more steam from the flash tank, while the flow of steam into the 600 lb per square inch absolute high pressure stage is not immediately affected. As the steam demand from the flash tank increases, the pressure in the tank drops, so that more water flows into the tank. The flash pump draws off more water from this tank to hold a constant level, and the amount of sub-cooled water entering the reactor increases. Consequently, the number of steam bubbles



The arrangement of the dual-cycle boiling reactor is illustrated in this diagram

within the core is reduced, and the reactor output rises to meet the load demand. It is to be noted that this stability during load changes is obtained without sacrifice of the inherent safety characteristics of boiling reactors. When reactivity is suddenly added to this reactor, there is a large increase in steam voids, which tends to shut the reactor down.

In the dual-cycle boiling reactor, the core consists of a vertical array of slightly enriched uranium rods. The fuel rods are supported in hexagonal zirconium coolant channels, which are arranged in a " honeycomb " pattern. These

coolant channels extend above the reactor core, to form " chimneys " which are used to promote natural circulation of the steam-water mixture. Control of the reactor is by vertical rods, which are actuated by hydraulic pistons. There are enough rods so that it is possible to move an individual rod quite freely without seriously affecting the reactor power level.

Reactor Core

The chain-reacting core of the dual-cycle boiling reactor is contained in a pressure vessel. The pressure-tight lid provides ample access for repairs to the reactor, or for the replacement of fuel. This lid is sealed so that the internal pressure in the tank tends to seat this closure during operation. The reactor tank is filled with water during fuel reloading or repair work. This thickness of water provides a biological shielding against the radiation from the spent fuel which is important during fuel reloading operations. The upper part of the tank serves as a steam dome, to dampen pressure variations in the reactor, so that rapid power fluctuations do not materially affect the reactor voids. The steam dome volume is also used as a region where the steam velocity is reduced, so that the bulk of the entrained moisture precipitates.

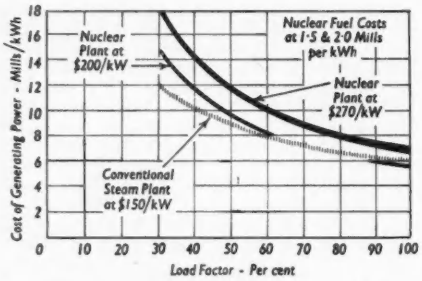
The water returns to the reactor by natural circulation, passing down the outer portion of the reactor tank, around the reactor core. This water mixes with the water from the feed and flash system, and the combined flow enters the bottom of the reactor core. The two 350 lb per square inch (absolute) flash tanks are mounted upon the same cylindrical supporting structure that holds the reactor pressure vessel. This arrangement makes it possible to use the flash tanks as the supports for the 600 lb per square inch (absolute) steam drum. With this arrangement, operating temperature differentials throughout the drums and piping system do not introduce appreciable thermal stresses in the piping. The simplicity and small size of this reactor plant compared to conventional boilers presents an indication of the future potential for cost reduction and for vigorous competition with conventional steam generating plants.

The principal advantages of the dual-cycle reactor may be summarised as follows : (1) The primary loop pressure is essentially the same as the turbine pressure ; (2) it has good thermal efficiency for a given reactor temperature ; (3) it has an exceptionally high degree of inherent safety due to boiling in the reactor ; (4) it has flexibility of operation to meet power demand changes without delay ; (5) it has a self-stabilising power level to match load variations.

Economic Considerations

It has been estimated that the installed cost of a power station based on the dual-cycle boiling reactor would lie somewhere between 200 dollars and 270 dollars per kilowatt of net output. This figure has been developed excluding the cost of purchasing the site, because land costs vary so widely throughout the United States. It must be remembered, however, that cost of land will be a relatively small part of the total cost, because the inherent safety of the dual-cycle boiling reactor will minimise the amount of land needed for safety requirements. As far as power costs are concerned, one can assume a rate of fixed charges amounting to 14 per cent per year. This 14 per cent includes return on investment, taxes, depreciation and insurance, and it is comparable to the charges now levied on conventional American power stations. The operation and maintenance costs for a nuclear power plant have been estimated to be about 5·60 dollars per kilowatt per year, as against 3·50 dollars per kilowatt per year for a conventional steam generating station of comparable size. It is more expensive, but this is because—at least at first—the nuclear power plant will require more operators than the conventional steam plant. And, of course, there will be additional costs associated with security, fuel accountability, health, &c.

While it is not yet permitted to disclose definite fuel cost, it can be assumed for the moment that costs will lie somewhere between 1·5 mils* and 2·0 mils per kilowatt-hour. With these figures in mind, the following comparisons are made. At present the installed cost for a good conventional American steam power station is about 150 dollars per kilowatt, the operating and maintenance cost is 3·50 dollars per kilowatt the net station heat rate is 9000 B.Th.U. per kilowatt and the fuel cost is 35 cents per million B.Th.U. The accompanying graph shows the relative cost of producing power in a dual-cycle reactor power plant and in a conventional steam power plant as a function of the load factor on the power plant. The figures for the nuclear power plant are, of course, based on the assumed investment costs and fuel costs. It can readily be seen



Comparison of power generating costs by nuclear and conventional methods

that at high load factors, or as a base load plant, the higher cost dual-cycle reactor plant is almost competitive with the steam power plant. But before nuclear power can be competitive at lower load factors, a way must be found to lower its initial costs.

When considering nuclear-powered generating plants for future power systems, it is important to remember certain basic requirements which these installations will have to meet : (1) The plant should be able to pick up load as rapidly as present steam-electric generating plants. The General Electric Company feels that the dual-cycle boiling reactor can meet this requirement. (2) From any load the plant should be able to drop part of the load and then to continue operation satisfactorily at some lower load. The importance of this particular requirement will depend upon the design of the plant. If a plant had a single reactor supplying steam to two steam turbines, it might be necessary to reduce reactor load practically instantaneously from 100 to 50 per cent if one turbine tripped out. In certain reactors, providing sufficient control range to accomplish this may be very difficult. (3) If the plant is to be operated as a " peaking " unit, it may be necessary to start and stop the unit frequently. The nuclear plant, therefore, ought to be capable of being restarted after over-night or week-end shutdowns. Again, in some reactors, there may be serious difficulties in providing sufficient control range to overcome the build-up of poisons in the reactor. Even where it is technically feasible, providing sufficient control range will probably be expensive either because of an increase in reactor size or because of a necessary increase in fuel enrichment. (4) The plant should be inherently safe so that it can be situated in populated areas near the load centres. The dual cycle boiling reactor will meet this important requirement.

Future Applications

Now that the dual-cycle boiling reactor has been developed as a pile suitable for operation in a power station in a large power system and now that nuclear generation is very nearly competitive in cost with the conventional steam-electric station at high load factor and in higher-cost fuel areas, it is of interest to speculate on how much of the future electric power production in the United States might be in nuclear-powered plants. The company has made forecasts, both optimistic and pessimistic, concerning the probable installed cost of atomic power plants in dollars per kilowatt for the period up to 1980. The pessimistic forecast starts at 270 dollars per net kilowatt in 1960 and drops to 165 dollars per net kilowatt by 1980, while the optimistic forecast starts at 200 dollars per net kilowatt in 1960 and drops to 145 dollars per net kilowatt by 1980. Similar thoughts apply to nuclear fuel costs over the same period. It is believed that by 1965 it will be entirely possible to achieve a long burn-up fuel element with fuel cost as low as 1 mil to 1·5 mils per kilowatt-hour. Certainly it is very likely that fuel cost by 1965 will be below 3 mils per kilowatt-hour, especially since the market price of uranium over the next 20 years or so will tend to stay steady and might even go down. Over the same period, it can be assumed that conventional steam-electric generating stations will continue to grow more efficient and that steam temperatures and pressures will increase at the same rate as in the past. Probably, higher steam conditions will mean higher costs, but it is very likely that other cost-saving design developments will more than offset this increase. For this reason, it is reasonable to assume that the cost per kilowatt of steam generating stations will remain at about 150 dollars per kilowatt.

Because of the wide variations in fuel costs in different parts of the United States, it is fairly obvious that a nuclear power plant can become competitive sooner in some areas than in others. The price of coal will probably remain steady in America over the next twenty years, mostly because any increase in labour costs will be matched by the savings made possible through increased mechanisation. Oil and natural gas, on the other hand, are expected to rise in price. One can anticipate, therefore, a gradual transition from oil and natural gas to coal as well as some increase in the average fuel cost throughout the country. By using a little judgment as to the rate of growth for a new industry, and by various combinations based on estimates and assumptions, the General Electric Company has forecast the percentage of new power stations in America which will be nuclear between now and 1980. From 2 per cent in 1960 and 1965, the total climbs to 14 per cent in 1970 to 44 per cent in 1975, and to 65 per cent in 1980. If conventional steam power plants fail to improve their efficiency during this same period, there will be a greater percentage of nuclear-powered systems. To grasp what these percentages mean in terms of kilowatts, it has been assumed that the total installed generating capacity in the United States will increase at a rate of about 6·5 per cent per year between now and 1980. This rate of increase is in close agreement with an average of estimates made recently by the Edison Electric Institute in its forecasts up to 1975.

Aluminium Reduction Works in Montana

The new aluminium reduction facility of the Anaconda Aluminum Company at Columbia Falls, Montana, was formally opened on August 15th. The firm expects the new works to reach its planned capacity of 60,000 tons annually by January 1, 1956. About 450 persons will be regularly employed when the plant is in full production. The plant is expected to use annually 120,000 tons of alumina—chemically refined bauxite, which is mined in Jamaica, in the British West Indies. The alumina is shipped to Montana by rail from the Corpus Christi, Texas, and Hurricane Creek, Arkansas, plants of the Reynolds Aluminum Company.

In planning the new facility, an adaptation of the plant design of the largest producer of aluminium in France, the Pechiney Company, was used. It is hoped that the French technology adopted for the Columbia Fall plant will produce aluminium at the lowest rate of kilowatt-hour consumption in America. Each of the pots will produce from 1400 lb to 1500 lb of aluminium in a twenty-four-hour period. Once the plant gets into operation the pots will be tapped every twenty-four hours. There are two potlines (240 pots) in the four 1180ft long pot buildings. The first potline of 120 pots went into operation last month.

The new works is 95 per cent owned by the Anaconda Company. The Harvey Machine Company retains a 5 per cent interest in the Anaconda Aluminum Company. This relationship goes back to 1952, when the Anaconda Aluminum Company was organised,

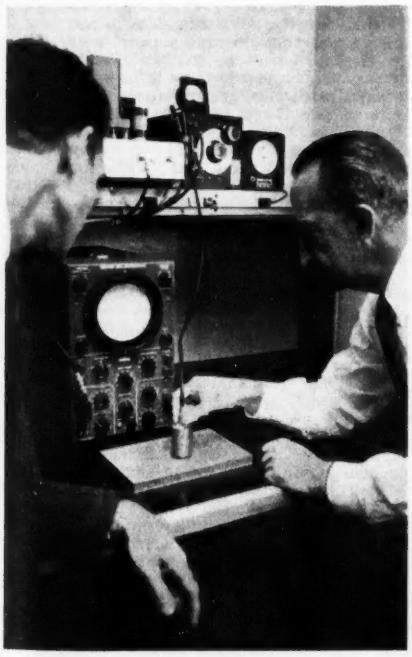
* 1 mil = 0·001 dollar.

based on the Harvey Machine Company, of Montana. The latter company had power contracts with the Bonneville Power Administration, a certificate of necessity, and other assets which were transferred to the Anaconda organisation. The key to aluminium production in this vicinity is the cheap, abundant power available from the Hungry Horse dam, as a part of the Bonneville power system. The new works is situated only 7 miles north-west of the dam.

Ultrasonic Bond Meter

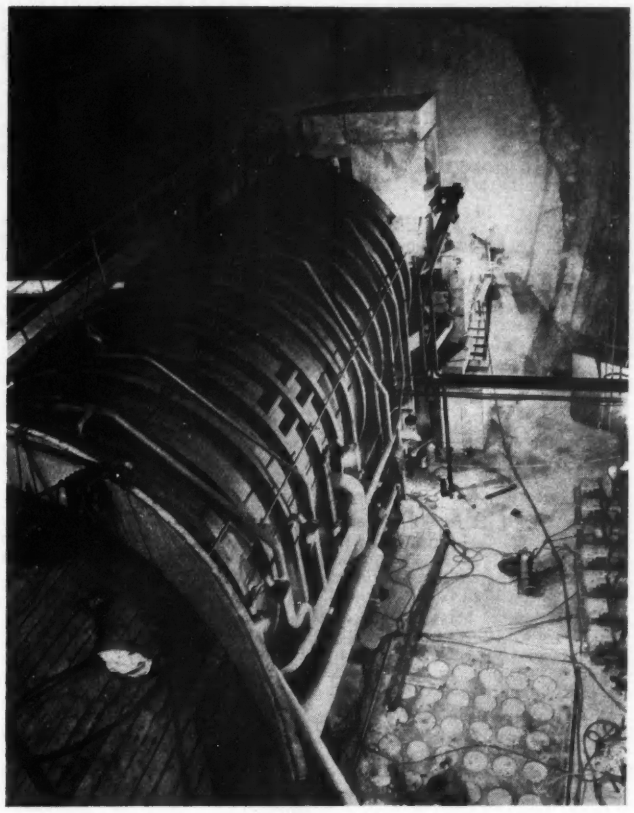
WITH the development of metal-sandwich structures bonded with synthetic adhesives, the question has arisen to what extent they can be used, especially in the aircraft industry, for stress-bearing parts. So far the application of these materials has been limited chiefly to such non-structural elements as floors and partitions. A reliable non-destructive test, however, could make it possible to fabricate fuselages, airfoils and even helicopter rotor blades of adhesive-bonded structures. In order to find some such suitable test the U.S. Air Force passed the problem over to a number of organisations, including the Stanford Research Institute, for study. From investigations carried out at Stanford, a non-destructive testing device to fill this need has been designed ; it is called the " Stub " meter (*ST*anford *U*ltrasonic *B*ond meter).

As a source of ultrasonic energy the " Stub " meter utilises a vibrating ceramic plate of barium titanate which receives its power from a high-frequency vacuum-valve generator. When this material is placed in an alternating electric field its dimensions change and it exhibits the phenomenon of resonance, its motion becoming more violent when it is driven by the electric field at its own natural vibration frequency. When, however, the plate is restricted in its motion by being attached to something else, the vibration becomes less violent and it is this difference in the response of the ceramic to different conditions of constraint that makes its use possible in the evaluation of adhesive bonds. In use the ceramic probe is attached to the test specimen by a thin liquid film, which, at high frequencies, behaves like a solid mechanical connection. The frequency of the generator supplying the probe is varied cyclically through resonance, and the presence of an adhesive bond alters the shape of this resonance curve. The response curve, typical of a panel known to be well bonded, is used as a control for comparing results, and defective bonds can be located by the difference in shape of the resonance curve.



Use of Stanford ultrasonic bond meter in testing honeycomb panel

From measurements on the resonance curve it is possible to determine the electrical quantity known as " Q." This quantity, which measures sharpness of resonance, has been shown to exhibit good quantitative correlation with the strength of the bond being tested, such correlation being determined by a calibration procedure in which panels are surveyed in detail by the " Stub " meter and then tested to destruction for verification of the meter findings. Most experiments at the Institute have been conducted with sandwich and laminated metal constructions, the tests with the latter appearing to be equally capable of revealing poor bonds as the sandwich experiments, though fewer destructive tests have been made. Work at Stanford has indicated that the "Stub" meter detects bond strength only in the area immediately connected to the vibrating ceramic plate, and faults on one side of a sandwich plate are not detected from the opposite side. In the case of multi-layer laminates, void areas can sometimes be located through several well-bonded layers.



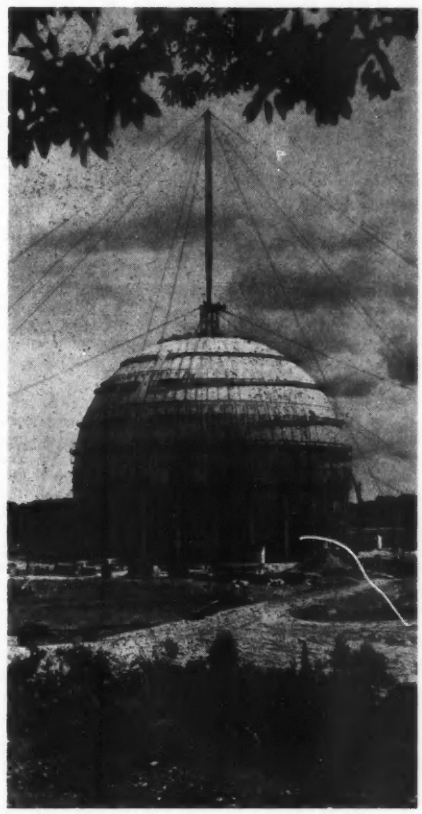
Submarine hull section and water tank surrounding prototype submarine reactor inside steel sphere at West Milton

It is being found that the " Stub " device has also other useful applications. For instance, a special version of the meter could be developed for testing the quality of bond in those aircraft propellers which are fitted with a foamed plastic to dampen blade vibrations, it being essential that the filling remains perfectly bonded to the metal parts. Such testing should help to forestall aircraft accidents in which the loss of an engine is involved through propeller unbalance. Other applications of the device could include the testing of any layered structure in which one layer absorbs more vibratory energy than adjacent layers, the monitoring and control of the curing process of plastics, and the inspection of rubber-metal bonds.

Generation of Commercial Atomic Power

THE first commercial atomic electric power to be produced for sale to the American public was generated at West Milton, New York, on July 18th and sent out over the lines of the Niagara Mohawk Power Corporation. Steam produced by the land-based submarine intermediate reactor of the U.S. Atomic Energy Commission was used to drive a 12·5MW turbo-generator, which was installed and operated for this purpose by the General Electric Company, of Schenectady, New York.

Using the by-product energy generated by the experimental operation of the prototype reactor for the submarine U.S.S. " Seawolf," the turbo-generator is now producing electricity for use in homes and industries in the upstate New York area. The power is being generated by General Electric, at no expense to the American Government, as a means of demonstrating the peacetime use of atomic power. The arrangement under which the power will be marketed by the Niagara Mohawk concern is temporary, pending determination whether any or all of three public power organisations within a 100-mile radius of West Milton, which have expressed interest in purchasing the power, can arrange for transmission to their grid systems. Inside a 225ft steel sphere the prototype nuclear reactor produces heat that is transferred to a heat exchanger, where water is converted to steam. At West Milton a portion of this steam is now used to operate the turbo-generator and to produce commercial power.



Steel sphere at West Milton containing prototype submarine reactor plant

Personal and Business

Appointments

MR. J. W. BLACKSHAW has joined the board of Elgar Machine Tool Company, Ltd., Hampton Road West, Hanworth, Middlesex.

THE LONDON MIDLAND REGION OF BRITISH RAILWAYS states that Mr. K. S. Martin, A.M.I.C.E., has been appointed district engineer, Derby North.

MR. R. H. COLLCUTT, has been appointed head of the operational research section of the British Iron and Steel Research Association, in succession to Mr. R. T. Eddison.

MR. A. P. HARVEY, A.M.I.E.E., has been appointed chief engineer of the switchgear division of Brush Electrical Engineering Co., Ltd., Loughborough, in succession to Mr. V. W. Lowe.

MR. C. E. H. VERITY, M.I.C.E., M.I.Mech.E., M.I.E.E., is relinquishing his position as deputy chief engineer (generation station construction), Central Electricity Authority, to take up an appointment on the board of Foster Wheeler, Ltd.

MR. A. J. NICHOLSON has left the staff of the Department of Agricultural Engineering, King's College, Newcastle upon Tyne, to take up an appointment in the research department of the British United Shoe Machinery Co., Ltd., Union Works, Leicester.

THE MARCONI INTERNATIONAL MARINE COMMUNICATION CO., Ltd., Chelmsford, states that Mr. H. C. Maguire has been appointed to the new post of export sales manager. He will be succeeded as manager of the Liverpool depot by Mr. J. Mitchell.

LLOYD'S REGISTER OF SHIPPING states that Mr. J. Worsnald, a senior ship and engineer surveyor at Cardiff, has been appointed principal surveyor for the Bristol Channel ports. He succeeds Mr. C. H. Stocks, who is retiring at the end of the month after thirty-six years in the service of Lloyd's Register.

BAKELITE, Ltd., 12, Grosvenor Gardens, London, S.W.1, states that Mr. G. W. Hodds is to become managing director on November 1st on the retirement from that position of Mr. H. V. Potter. Mr. Potter will continue as chairman of the company. Mr. F. J. Robinson is relinquishing the position of deputy managing director.

MR. VERNON YOUNG, has been appointed chairman of International Combustion, Ltd., 19, Woburn Place, London, W.C.1. Mr. W. Grainger and Mr. John Mayer, who recently became joint managing directors of International Combustion (Holdings), Ltd., have also been appointed joint managing directors of International Combustion, Ltd.

THE MINISTRY OF SUPPLY states that Mr. E. T. Jones has been appointed director-general of technical development (air) in succession to Mr. G. W. H. Gardner who is to become director of the Royal Aircraft Establishment, Farnborough, on November 1st. Dr. W. Cawood has been appointed to succeed Mr. Jones as principal director of scientific research (air).

FERODO, Ltd., Chapel-en-le-Frith, states that Mr. G. S. Sutcliffe, sales director, is to become managing director, and that Mr. E. R. Pochin, home sales manager, is joining the board as home sales director. Mr. M. H. Good has been appointed home sales manager and Dr. N. Carpenter, technical sales manager. These appointments are consequent upon the forthcoming retirement of Mr. William Smith from the position of managing director.

THE BRITISH BROADCASTING CORPORATION announces the appointment of Mr. J. J. Allen as engineer-in-charge of the new Channel Islands television transmitting station at Les Platons, Jersey. Mr. W. Balfour has been appointed engineer-in-charge of the new television transmitting station at Meldrum, Aberdeenshire, and Mr. H. F. Bowden is to become engineer-in-charge of the short-wave transmitting station at Skelton, Cumberland, following the retirement of Mr. S. A. Williams.

Business Announcements

MR. N. L. GOODCHILD, managing director of Cowlishaw Walker and Co. (London), Ltd., is in the U.S.A. visiting press shops in Chicago and Detroit to examine automatic transfer technique as applied to power presses.

BIRMETALS, Ltd., and Douglas Holt (Est. 1919), Ltd., state that they are merging their respective filling compounds "Filzall" and "Instant Loy" and that the resulting product will bear both names. Inquiries concerning it should be made to Douglas Holt (Est. 1919), Ltd., 5-6, Eagle Street, London, W.C.1.

THE BRISTOL AEROPLANE COMPANY, Ltd., has announced that the functions of the aircraft, aero-engine and car divisions are to be transferred to three new subsidiary companies, Bristol Aircraft, Ltd., Bristol Aero-Engines, Ltd., and Bristol Cars, Ltd. The chairmen of the new companies are Mr. C. F. Uwins, Air Chief Marshal Sir Alec Coryton, and Mr. George White. Mr. P. G. Masefield is to take up the managing directorship of Bristol Aircraft, Ltd., on January 1st next.

Contracts

LEYLAND MOTORS, Ltd., has received an order for a further twenty-eight eight-wheel trucks of 24-ton gross rating for the British Road Services.

Miscellanea

CORRECTION.—In the article "S.B.A.C. Flying Display and Exhibition," on page 372 in our last issue, an error occurred in the reference to the "Double Mamba" engine. This power unit is manufactured by Armstrong Siddeley Motors, Ltd.

REFINED PIG LEAD EXPORTS.—The Board of Trade announces the issue of an open general licence authorising the export to any destination other than China, Macao, North Viet Nam or Tibet of specified brands of refined pig lead. This licence came into operation on September 14th; copies are obtainable from H.M. Stationery Office, Kingsway, London, W.C.2.

RADIO ENGINEERS' AWARD.—The British Institution of Radio Engineers has stated that its premier award, the Clerk Maxwell premium, is to be made to Mr. F. N. H. Robinson for his paper entitled "Microwave Short Noise in Electron Beams and the Minimum Noise Factor in Travelling Wave Tubes and Klystrons." Mr. Robinson is a Research Fellow at the Clarendon Laboratory, Oxford.

BRITISH ASSOCIATION ESSAY COMPETITION.—At the recent Bristol meeting of the British Association, the president, Sir Robert Robinson, presented prizes to the winners of a scientific essay competition which, for the sixth successive year, has been sponsored by *Endeavour*. The second prize of twenty-five guineas was gained by Mr. D. Hull, University College, Cardiff, for an essay entitled "New Metals for Engineers."

ELLIOTT CRESSON MEDAL.—The Franklin Institute, Philadelphia, has announced that the Elliott Cresson medal is this year to be awarded to Dr. F. P. Bowden, Reader in Physical Chemistry at Cambridge University. This award is made to Dr. Bowden for "his extensive experimental investigations which combine simplicity and clarity, and for his findings regarding the detailed nature of the processes involved when one metal slides over another."

LAUNCH OF HOPPER BARGE.—The second of three hopper barges building for the Government of Queensland was launched from the yard of Brooke Marine, Ltd., on August 22nd. M.V. "Cowrie" has a length overall of 170ft, a breadth moulded of 33ft, a loaded draught of 11ft, a deadweight of 675 tons and a service speed of 10 knots. The "Cowrie" will sail to Australia under her own power and is expected to complete the 13,000 mile voyage in about eight weeks.

STRIP METAL USERS' CONFERENCE.—The Sheet and Strip Metal Users' Technical Association is to hold a conference on "Modern Materials" on Monday and Tuesday, October 10th and 11th, at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. Prior to the official opening of this conference on Monday, October 10th, the annual general meeting of the Association will be held at 10 a.m. Full details of the conference may be obtained from the Hon Secretary of the Sheet and Strip Metal Users' Technical Association, 17–19, John Adam Street, London, W.C.2.

RESEARCH STATION FOR TUBE INVESTMENTS, LTD., AT WALSALL.—It is announced by Tube Investments, Ltd., that an applied research station is being set up at Walsall to supplement facilities already available at the group's research laboratories at Cambridge and Birmingham. The new station will be opened early in October and it will initially house three sections of the group's technological department. At the new Walsall establishment an irradiated materials section will be directed by Dr. A. Charlesby, formerly of the Atomic Energy Research Establishment, Harwell. Its development work will be particularly concerned with irradiated plastics. The materials will be irradiated in the first instance at the Tube Investments Research Laboratories, at Cambridge, where an electron accelerator is now being installed. A plastics development section, directed by Mr. J. E. Gordon, will be concerned with the development of processes and the necessary machines to be used in the plastics industry to take advantage of the chemical advances of recent times. A further team, under the direction of Mr. C. A. Cochrane, will be concerned with control engineering, including the application of electronic techniques to industrial processes.

IRON AND STEEL ENGINEERS' GROUP.—The Iron and Steel Institute has announced that the next meeting of junior engineers is to be held in London from Monday to Thursday, September 26th to 29th. The meeting will begin at 3.30 p.m., on September 26th, at 4, Grosvenor Gardens, S.W.1, when a lecture entitled "The Corby Works of Stewarts and Lloyds, Ltd.," will be given by Mr. J. Daniel and Mr. D. Bird and a paper by Mr. F. Starkey on "Guides and Strippers for Rod and Bar Mills" will be discussed. On September 27th, there is an all-day visit to Ford Motor Co., Ltd., at Dagenham, and on the following day those attending the meeting will visit the Corby works of Stewarts and Lloyds, Ltd. On the morning of Thursday, September 29th, at 4, Grosvenor Gardens, Mr. Sven Fornander will lecture on "The Iron and Steel Industry of Sweden." Any members of the iron and steel and associated industries will be welcome at the meeting provided they are under thirty-five.

BRITISH RAILWAYS' MODERNISATION PLAN.—Work has begun on the remodelling of the up goods yard at Hatfield, in the Eastern Region of British Railways. The alterations being carried out, it is stated, will simplify the permanent way layout and reduce maintenance and renewal costs. In addition to the permanent way alterations, a water column near the goods shed will be removed and the fixed crane will be resited in a better position adjacent to the shed. The estimated cost of the work is £14,000 and it is hoped to complete the scheme by the end of this year. Some further details have been given about the scheme for additional track circuiting at Crescent Junction signalbox, Peterborough, which includes the provision of nineteen track circuits at the south end of Peterborough (North) station, in addition to the seven already existing. All track circuits will be power fed and a new, normally "out," illuminated diagram will be provided in the signalbox. The provision of the additional track circuits will make it possible to dispense with seventeen facing point lock bars and one electric depression bar. The electrical equipment will be housed in the existing relay room adjacent to the signalbox. It is anticipated that work on this scheme will begin later this year and will be completed by December, 1956. The estimated cost of the work is £5400.

HYDRO-SKIS FOR AIRCRAFT.—The current issue of *Saro Progress*, quarterly magazine of the Saunders-Roe Group, contains the first part of an account of the Saro development work on hydro-skis, a subject to which much attention has been attracted by the Convair "Sea Dart" jet fighter and the Stroukoff "panto-base" transport. The article points out that the earlier types of aircraft float were clearly intended to act as hydro-skis, but that the demand for low drag, both flying and planing, caused the V-bottom to become universal. Three factors are now calling for a revival of the ski; jet aircraft can be allowed to float much lower on the water than propeller-driven machines, rising thrust-weight ratios make planing drag less critical, and finally, a small ski, in rough water, imposes lesser accelerations on a hull than a large planing bottom. Saunders-Roe work was originally intended to perfect a ski undercarriage for a high-speed fighter. An early experiment showed that three part-circular sectioned plates spaced out along the body gave an unacceptably high "hump" of 0·45× weight to the drag curve, but for a fuselage resembling a very fine hull with a broad segment amidships arranged to tilt like a ski heel the figure was down to 0·35. Subsequent schemes incorporated longitudinal sections extending and rolling to give reversed dead rise, and could be designed to give good trim characteristics. The skis were developed to promise satisfactory take-off in calm or rough water. An Auster "J5G" was then acquired for full-scale tests, and test skis pivoted about the wheel centre were proved on a model; towing tank tests showed a high resistance, which was overcome by fitting a small step to break suction loads under the end of the ski, reducing wheel protuberance and using retractable "flips" along the sides of the ski. The optimum ski attitude was found to be 2½ deg. nose up. A colour photograph shows the Auster itself taxi-ing on the River Medina.

British Patent Specifications

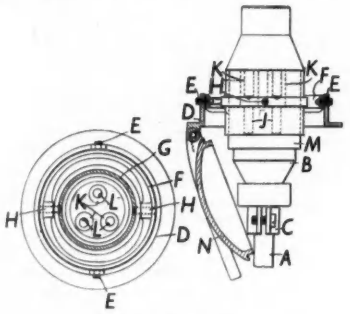
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. each.

ELECTRICAL ENGINEERING

734,417. June 16, 1952.—CONNECTIONS BETWEEN ELECTRIC MAINS AND A VEHICLE, Simmonds and Stokes (Niphan), Ltd., Victoria House, Southampton Row, London, W.C.1. (*Inventor: Geoffrey Edward Dormor.*)

For cases in which temporary connection must be made between fixed mains and a freely moving vehicle, according to the invention, one part of a plug and socket connector is connected through a length of flexible cable with the mains, and the other is so mounted on the vehicle that it can swing under a pull from the cable in any direction within a substantial angle so that the connection can be broken upon the vehicle moving off in any direction over a wide arc without strain upon the connector. As will be seen from the drawing, connection to the supply mains is made through a flexible cable *A* to the end of which is connected a socket *B* which is also mechanically made fast upon the cable by the clamp *C*.

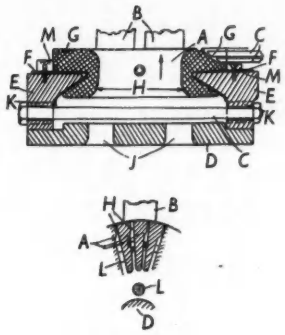


No. 734,417

On the vehicle there is rigidly secured a shell *D* carrying pivots *E* upon which turns a gimbal ring *F*. Within the gimbal ring there is pivoted to the ring the plug part *G* of the connector. The pivots *H*, which connect this to the ring *F*, are at right angles to that passing through the pivots *E*. The plugs *J* of the part *G* may be integral in the usual way with tunnelled fittings *K* in which conductors can be secured by clamping screws *L*. Since the part *B* will fall on the ground if the vehicle is driven away before the part has been withdrawn, it is preferable to shield it in rubber *M*. To cover the plugs *J* when not in use a spring-loaded cover *N* may be hinged upon the mounting. As soon as the socket is disengaged this cover closes over the opening in the mounting and so shields the plugs. The construction ensures that a vehicle can be driven away without hesitation and without damage to the connector whether or not it was parked exactly in register with the mains connection. In the case of a crane it relieves the armoured connecting cable of much of the bending to which it would otherwise be subjected. In lieu of gimbal rings any other form of universal coupling allowing of wide swing and not interfering with the making of electrical connections may be employed.—*August* 3, 1955.

734,696. October 21, 1952.—COMMUTATORS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventors: Arthur Clive Lane and John Whitcroft.*)

According to the invention, in a commutator having segments circumferentially separated from one another and held on a hub or shaft by end rings of vee-section, the segments are separated by insulation which extends for only a part of the axial space between them so as to leave radial passages for the flow of cooling gaseous medium giving better heat dissipation. In the drawing *A* represents commutator segments, *B* the brushes and *C* the armature winding connections. The segments are held on a shaft or hub *D* by end rings *E* of vee-shape in cross-section. The end rings enter notches in the ends of the segments, from which they are separated by insulation *F*, the segments being clamped by the end rings which are held together by bolts as shown. The insulation *F* is generally of mica, as is the insulation *G* which separates the segments from one another. Whereas in commutators of this construction as hitherto made, the insulation *G* extends over the whole axial length of the segments, according to the invention, the insulation is omitted from between the segments over at least part of the axial space underlying the track of the brushes, as indicated at *H*, so as to form radially extending passages for the flow of cooling gaseous medium induced wholly or in part by the rotation of the commutator during operation. Passages *J* in the hub *D* may be formed to permit the cooling medium flow to the segments; alternatively or in addition to passages *J*, apertures indicated at *K* may be provided in the end rings *E*, if desired. The segments may be shaped as indicated in the lower view to widen the space to increase the flow of cooling medium. The cooling medium will



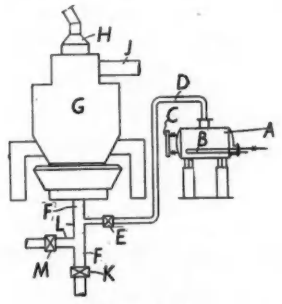
No. 734,696

generally be air, but for large machines hydrogen may be used in some circumstances. The hub *D* will generally be assembled directly on the shaft of the machine. Alternatively, the spider may be arranged on the shaft, the outer periphery of which receives the hub. Generally the commutator bars will be sufficiently rigid to withstand the clamping pressure without distortion, but in particular instances where this may occur spacing buttons *L* of a suitable material, such as fused mica glass, may be included in the assembly between the bars. In order to prevent twisting of the bars, locating pieces of insulating material could be fitted at each end of the commutator, as shown at *M* in the upper view. The width of these pieces would be equivalent to several segments of the commutator which would require to be slotted to provide the location.—*August* 3, 1955.

GAS PLANTS

734,802. August 9, 1954.—PRODUCTION OF COMBUSTIBLE GAS, The Gas Council, Gas Industry House, 1, Grosvenor Place, London, S.W.1. (*Inventors: John Edward Davis and Harold Stanier.*)

The invention provides a process for the production of combustible gas, in which methanol vapour is converted by thermal decomposition into carbon monoxide and hydrogen by passing it, if desired, in admixture with steam to bring about the water gas reaction, through solid carbonaceous fuel at a temperature of at least 700 deg. Cent., and the fuel is intermittently reheated by the passage of air through it. The thermal decomposition of methanol may be represented as follows: $CH_3OH \rightarrow CO+2H_2$. The process of the invention is illus-



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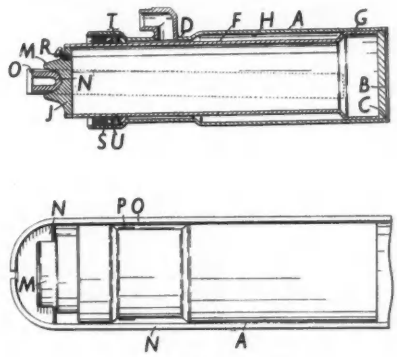
trated in the drawing. Liquid methanol is evaporated in a boiler *A* by means of a steam coil *B*. *C* is a sight glass to indicate the level of the liquid methanol. The methanol vapour passes through a pipe *D*, valve *E* and pipe *F* into a bed of carbonaceous fuel in a conventional water gas generator *G*. Fuel is charged into the generator through an inlet connection *H* and the gases leave the generator through a pipe *J*. When steam is also used, it is introduced into the pipe *F* through a valve *K*. Air for heating and reheating the fuel is introduced through a pipe *L* controlled by a valve *M*. The fuel bed is first raised to a temperature of 1250 deg. Cent. by blowing in air. Methanol vapour alone, or in admixture with steam, is then introduced until the temperature of the bed has fallen to about 800 deg. Cent. Air is then introduced to reheat the fuel bed, and the process is continued by repeating these alternate run and blow periods, the valve *E* (or valves *E* and *K*) being opened and the valve *M* closed during the run periods and vice versa during the blow periods. These valves may be automatically controlled. The gas containing carbon monoxide and hydrogen, which leaves the generator during the run periods through the pipe *J*, may be passed to a carburettor and superheater for enrichment with gaseous hydrocarbons. In view of the greater output from the conventional water gas generator, it may be necessary to increase the duration of the run periods relatively to that of the blow periods, and this may be achieved by conventional means.—*August* 10, 1955.

CRANES AND LIFTING DEVICES

734,401. April 29, 1950.—HYDRAULIC RAM OR JACK DEVICES, Massey-Harris-Ferguson (Sales), Ltd., formerly Harry Ferguson, Ltd., Fletchamstead Highway, Coventry. (*Inventor: Theo Sherwen.*)

The invention relates to hydraulic ram or jack devices for actuation of agricultural implements, and provides a simple construction. As the



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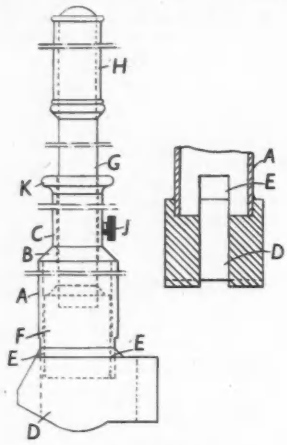
drawing shows, the ram cylinder *A* consists of a cold drawn steel tube with one end closed by a disc *B*. The tube wall is inwardly shaped to form an annular channel *D* and in this channel there is welded an oil supply or exhaust coupling bend. The ram is constituted by a similar tube *F* of smaller diameter formed at the end adjacent the closed cylinder end into an open-ended skirt *G* which fits slidably inside the cylinder bore *H* and constitutes a guide which, at the end of the outward stroke, contacts the annular channel *D*, which acts as a stop. The other end of the ram is closed by a welded disc or head *J*. The head has two transverse ridges *M* forming a cradle for a transverse bridge member *N* to which is secured two straps *O* which, at their other ends, are attached to the load to be moved. The bridge member *N* and straps *O* thus form a harness for connecting the ram to the load, the ram cylinder *A* being fixed by suitable clamps, including a U-shaped strap *P* engaging round the annular channel *D*. In the head *J* there is provided an air bleed valve consisting of a screw valve *R* formed with a flat on it. A gland assembly is provided inside the open end of the cylinder and consists of a steel ring *T* of L-shaped cross section of which the inward limb is embedded in and bonded to a rubber ring *U* having a slightly concave inner face bearing on the ram tube *F*. The rubber ring extends up the outer face of the steel ring and terminates in an annular projection forced into tight engagement with the curved end wall of the annular channel *D*. The gland is held in position by a metal collar *S* of cast iron, held by a split ring. The collar *S* also forms a guide for the ram *F*.—*August* 3, 1955.

RAILWAY ENGINEERING

734,695. October 20, 1952.—DRIVING SPRING STEEL RAIL SPIKES INTO SLEEPERS, Kenitra Company, Ltd., and Eric James Pannell, both of the company's address, 48/50, St. Mary Axe, London, E.C.3.

The invention is concerned with devices for driving spring steel rail spikes into sleepers. The following is a description of one form of device designed for use on spring steel rail spikes, which have the general shape of a simple hook, used with British Railways standard cast base plates. As the drawing shows, a lower tubular portion or guide *A* has welded to the top of it a ring *B* and a narrower tubular handle *C*. The guide and the handle are coaxial and of circular cross-section. Welded to the bottom of the guide are two arms of a gauge *D*, which is recessed to receive the guide *A*. The gauge *D* is of horseshoe shape and has two long parallel arms, the insides of the free ends of the arms being bevelled away from each other to allow the gauge to be readily slipped over a spike in a sleeper. The bottom of the gauge is so shaped as to allow it to rest firmly on a base plate. The bottom of the guide *A* has two diametrically opposed slots *E* corresponding to the space between the two arms of the gauge, the slots being for accom-

modating the top of a rail spike. A hammer head *F* consisting of a solid cylinder with a slight taper at the bottom is reciprocable within the guide *A*. Welded to the top of the hammer head *F* is a driving bar *G*, which is a loose fit in the handle *C*. The driving bar extends out of the handle so that its upper end, which is provided with a rubber hand grip *H*, can be grasped to actuate the hammer head. A clamping screw *J* is provided to hold the driving bar *G* against



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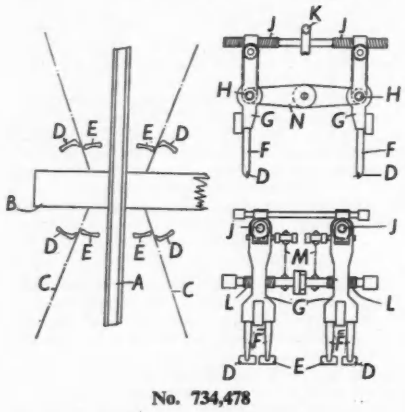
movement when the tool is being carried. To prevent pinching of the hand between the handle and the driving bar a hand protection ring *K* is provided. In operation, first a spike will usually be partly driven into position by a hammer. Then the device is placed vertically over the spike with the gauge resting on the base plate. The driving bar is raised to its full extent and thrust downwards. The hammer head thus strikes the spike and drives it into the sleeper. The movement is repeated until the hammer head strikes the top of the gauge and the spike is thereby correctly tensioned.—*August* 3, 1955.

734,478. December 10, 1953.—RAILWAY TRACK PACKING MACHINES, Walter Meissner, Dipl.-Ing., Herbertstrasse 22, Berlin-Grunewald, Germany.

The invention relates to a travelling railway track packing machine wherein the packing tools consist of picks provided with packing plates disposed edgewise and arranged on both sides of the lines of rails. These packing tools can be lifted and lowered, so that they can be introduced into the ballast. They also move relatively to one another by means of mechanically driven threaded spindles and are connected to a shaking device so that the ballast is



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packed by causing the packing tools to approach one another in the manner of tongs. In the drawing the left-hand view shows in plan a point of intersection of a rail with a sleeper and the position and form of packing plates provided in pairs. The rail lengths are shown at *A* and the sleepers at *B*. This drawing shows diagrammatically in addition to the rectilinear paths of movement *C* indicated in dash-dotted lines, two groups of packing tools *D* and *E*. Each group is separately driven off a common drive. The working faces of the packing plates which come into contact with the ballast are concave as seen in plan view, and lie somewhat at an angle to the path of movement. A particularly favourable form of drive is shown in the two right-hand views, which permits a path of movement of any desired form. The packing plates *D* and *E* are secured to the picks *F* or to parts of them, and the picks are interchangeably arranged in any desired manner in pick holders *G*. The tongs movement of the pick holders *G* with the picks *F* takes place about pivot pins *H*, with the aid of threaded spindles *J* which engage with the upper ends of the pick holders *G* and are actuated by a motor or similar drive through a worm gear *K*. The variation of the direction of the path of movement is caused by the pick arms *G* being laterally shifted in the region of their pivot pins *H* by means of the threaded spindles *L*. A hydraulic drive could equally well be provided in this case. The pick holders *G* move about the upper spindles *J*. Depending on the manner in which the spindles *L* are driven, it is possible to determine the form of the path of movement of the packing plates mounted on the lower end of the picks. The lateral movement of the pick holders *G* under the action of the spindles *L* can be produced by means of a common drive or by means of separate drives *M*, so that it is possible for the paths of movement of the picks operating on the outer side of the rail to have a different form from those of the picks operating on the inner side of the rail. *N* is the arrangement by which the shaking movement of the pivot pins of the packing arms in the direction of the path of movement of the packing tools is produced.—*August* 3, 1955.

Launches and Trial Trips

SIDERURGICA VII, collier ; built by the Forges et Chantiers de la Mediterranee for the Cie Siderurgica Nacional, Brazil ; length overall 474ft 1in, length between perpendiculars 441ft 6in, breadth moulded 57ft, depth to upper deck 37ft 4in, load draught 27ft 9in, deadweight 11,680 tons, displacement 15,800 tons ; machinery built by the Ateliers et Chantiers de France, one reciprocating steam engine 3700 i.h.p., supplied with steam at 225 lb per square inch by four oil burning cylindrical boilers, service speed 12 knots.—Trial August.

Catalogues and Brochures

DORMAN AND SMITH, Ltd., Ordsal Electrical Works, Manchester, 5.—Folder giving details of the "Roadmaster" circuit breaker unit.

GEORGE KENT, Ltd., Luton, Bedfordshire.—Leaflet describing the R.T.S. B.R.I.C. recorder/controller for use in the production of sugar from cane or beet.

YOUNG AND POWER, Branksome Court, The Avenue, Bournemouth West.—Illustrated folder describing "Therglas" electrically heated laminated glass.

FIRTH BROWN TOOLS, Ltd., Speedicut Works, Carlisle Street East, Sheffield, 4.—Publication No. 199/2, illustrating and describing "Zeelock" serrated blade cutters.

SIR W. H. BAILEY AND CO., Ltd., Patricroft, Lancashire.—Illustrated brochure giving details of an improved type of pilot-operated reducing valve known as Class "G3."

RANSOME AND MARLES BEARING COMPANY, Ltd., Newark, Notts.—Detailed catalogue covering a wide range of the ball and roller bearings manufactured by this company.

SIMON-CARVES, Ltd., Cheadle Heath, Stockport.—Brochure outlining in simple terms the broad principles of electro-precipitation, the basic points of design and construction.

STABILAG COMPANY, Ltd., Mark Road, Hemel Hempstead, Herts.—Leaflet describing the "Electrotap" unit for providing continuous regulation of the power consumption of electrical heating apparatus.

BAIRD AND TATLOCK (LONDON), Ltd., Chadwell Heath, Essex.—Brochure briefly describing some of the units compriaing one particular "Analmatic" laboratory which has already been built for a specific purpose.

STURTEVANT ENGINEERING COMPANY, Ltd., Southern House, Cannon Street, London, E.C.4.—Publication No. 3604, entitled "Exhaust Ventilation," illustrates the methods employed in localised exhaust ventilation.

ZINC DEVELOPMENT ASSOCIATION, 34, Berkeley Square, London, W.1.—Booklet entitled "Zinc Dust in Protective Coatings," reviewing the development of zinc metal pigmented paints, and describing their formulation, properties and applications.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Sept. 28th.—LONDON SECTION : School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Extending the Limits of Resistance Measurement Using Electronic Techniques," G. I. Hitchcox, 6.30 p.m.

Wed., Oct. 5th.—MERSEYSIDE SECTION : Chamber of Commerce, 1, Old Hall Street, Liverpool, 3, "Stereophonic Sound," R. A. Bull, 7 p.m.

Thurs., Oct. 6th.—N.W. SECTION : Reynolds Hall, College of Technology, Sackville Street, Manchester, "Colour Television," G. N. Patchett, 6.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Thurs. and Fri., Oct. 13th and 14th.—Conference Room, Campfield Avenue, Deansgate, Manchester. In connection with the Fuel Efficiency Exhibition (Wed., Oct. 12th to Sat., Oct. 22nd) the Association has arranged a Conference entitled "The Cost of Steam."

ENGINEERING INDUSTRIES ASSOCIATION

Wed. to Fri., October 12th to 14th.—Royal Horticultural Society's New Hall, Greycoat Street, London, S.W.1, Eighth London Regional Display.

ILLUMINATING ENGINEERING SOCIETY

Fri., Sept. 23rd.—BATH AND BRISTOL CENTRE : S.W. Electricity Board, Old Bridge Street, Bath, "Interior Decoration and its Effect upon Illumination," J. D. Layton, 7 p.m.——BIRMINGHAM CENTRE : Regent House, St. Phillip's Place, Colmore Row, Birmingham, Chairman's Address, G. R. Hanson, 6 p.m.

Mon., Sept. 26th.—LEEDS CENTRE : Chemistry Lecture Theatre, The University, Leeds, "The Brightness of the Stars," Sir Harold Spencer Jones, 7 p.m.——LEICESTER CENTRE : E. Midlands Electricity Board, Charles Street, Leicester, "Interesting Lighting Jobs," Papers by Members, 6 p.m.

Wed., Sept. 28th.—TRANSVAAL CENTRE : Room 95, Public Library, Johannesburg, "The Study of Natural Daylighting Using Models," W. M. H. Rennhakkamp, 8 p.m.

Mon., Oct. 3rd.—LEEDS CENTRE : Yorkshire Electricity Board, Ferensway, Hull, "Stage Lighting," P. Corry, 7 p.m.

INCORPORATED PLANT ENGINEERS

Wed., Sept. 21st.—KENT BRANCH : Bull Hotel, Rochester, "Building Construction for Industry," 7 p.m.——WESTERN BRANCH : Grand Hotel, Bristol, "Coal and Oil," 7.15 p.m.

Mon., Sept. 26th.—W. AND E. YORKS BRANCH : The University, Leeds, "Axial Flow Fans," R. H. Holbeche, 7.30 p.m.

Tues., Sept. 27th.—S. WALES BRANCH : S. Wales Institute of Engineers, Park Place, Cardiff, "Space Heating," W. M. Barber, 7.30 p.m.

Wed., Sept. 28th.—SHEFFIELD AND DISTRICT BRANCH : Grand Hotel, Sheffield, "Steelmaking and the Plant Engineer," R. Mayorcas, 7.30 p.m.

Fri., Sept. 30th.—BIRMINGHAM BRANCH : Imperial Hotel, Birmingham, "The Do's and Don'ts of Refrigeration," Malcolm E. Lea, 7.30 p.m.

Tues., Oct. 4th.—LONDON BRANCH : Royal Society of Arts, John Adam Street, Adelphi, W.C.2, "Air Pollution Problems and their Cure," J. B. M. Mason, 7 p.m.

INSTITUTE OF PHYSICS

Fri. and Sat., Sept. 23rd and 24th.—ELECTRONICS GROUP : 47, Belgrave Square, London, S.W.1, "Some Recent Developments in Magnetic Materials," Symposium.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Sept. 27th.—N.E. CENTRE : Three Tuns Hotel, Durham, "Gas Turbine Development for Road Transport," P. A. Phillips, 7 p.m.

INSTITUTE OF WELDING

Wed., Nov. 2nd, to Fri., Nov. 4th.—Autumn Meeting, London.

INSTITUTION OF ELECTRICAL ENGINEERS

Sat., Oct. 1st.—Visit to Brunswick Wharf Generating Station, 10.30 a.m.

Mon., Oct. 10th.—Savoy Place, London, W.C.2, Chairman's Address, "A.C. Switchgear," M. H. F. Collins, 6.30 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE

Wed., Oct. 12th.—St. Bride's Institute, Bride Lane, Fleet Street, London, E.C.4, Presidential Address, R. L. Quertier, 6.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 4th.—39, Elmbank Crescent, Glasgow, Presidential Address, A. M. Robb, 7.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Fri., Oct. 7th.—LONDON BRANCH : Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Aerial Surveys and Practical Application of Results Therefrom," Joint Papers, Hunting Aerosurvey's, Ltd., and B. F. J. Bradbeer, 5.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., Sept. 21st.—GENERAL MEETING : Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Presidential Address, K. J. Cook, 5.30 p.m.

Wed., Oct. 5th.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "The British Railways Mechanical Iron Foundry, Horwich," S. A. S. Smith, 5.30 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Tues., Oct. 4th.—ORDINARY MEETING : Institution of Electrical Engineers, Savoy Place, London, W.C.2, "Radio Aids to Marine Navigation," W. Dolman, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Sept. 19th.—SHEFFIELD GRADUATE SECTION : The Inspection Establishment, Jansen Street, Sheffield, "Screw Thread Gauging," 6.30 p.m.——N.E. SECTION : Neville Hall, Newcastle, upon Tyne, Address by Section Chairman, F. Baker, 7 p.m.——MANCHESTER SECTION : Reynolds Hall, College of Technology, Manchester, "Lubrication," H. E. Priston, 7.15 p.m.

Wed., Sept. 21st.—LONDON GRADUATE SECTION : 10, Chesterfield Street, London, W.1, "Industrial Gases with Particular Reference to Oxygen and Acetylene," F. D. Hucklesby, 7.15 p.m.——BIRMINGHAM SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, "Material Utilisation," R. M. Evans, 7 p.m.

Fri., Sept. 23rd.—S. WALES AND MONMOUTHSHIRE SECTION : S. Wales Institute of Engineers, Park Place, Cardiff, "Extrusion of Metals," J. T. Lewis, 7 p.m.

Tues., Sept. 27th.—LUTON SECTION : W. H. Allen, Sons and Co., Ltd., Queens Works, Bedford, "Materials Handling," K. B. Warwick and H. Dean, 7.30 p.m.

IRON AND STEEL INSTITUTE

Wed. to Fri., Oct. 12th to 14th.—Special Meeting in Scunthorpe.

ROYAL AERONAUTICAL SOCIETY

Thurs., Oct. 6th.—BRITISH COMMONWEALTH AND EMPIRE LECTURE : Royal Institution, 21, Albemarle Street, London, W.1, "The Growth of Aeronautical Research in Canada during the Post-War Decade," J. J. Green, 6 p.m.

SHEET AND STRIP METAL USERS' TECHNICAL ASSOCIATION

Mon. and Tues., Oct. 10th and 11th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, Special Conference on Modern Materials.